Taking a Financial Position in Your Opponent in Litigation[*]

Albert H. Choi
University of Virginia Law School

Kathryn E. Spier
Harvard Law School

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Abstract

We explore a model of litigation where the party bringing the lawsuit, the plaintiff, can acquire a financial position in the target firm, the defendant. The plaintiff gains a strategic advantage by taking a short financial position in the defendant's stock. First, the plaintiff can turn what would otherwise be a negative expected value claim (including a frivolous one) into a positive expected value one. Second, the short financial position raises the minimum amount the plaintiff is willing to accept in settlement, thereby increasing the settlement amount. Conversely, taking a long position in the defendant's stock puts the plaintiff at a strategic disadvantage. When the capital market is initially unaware of the lawsuit, the plaintiff can profit both directly and indirectly from its financial position. When the defendant is privately informed of the merit of the case, the plaintiff balances the strategic benefits of short position against the costs of bargaining failure and trial. Short selling by the plaintiff can, under certain circumstances, benefit both the plaintiff and the defendant and also reduce the rate of litigation.

Introduction

In litigation, the party bringing the lawsuit sometimes has an additional financial interest in his or her opponent, an interest that extends beyond the boundaries of the lawsuit itself. In some situations, plaintiffs maintain a "long" financial position. In securities litigation, for instance, the plaintiffs are typically a subset of the firm's current shareholders.[1] In other situations, plaintiffs have "short" financial positions. Recently, a prominent hedge fund manager has brought patent challenges against pharmaceutical companies while shorting their stock.[2] Since the market value of a publicly-traded defendant reacts to new information, a plaintiff who holds a financial interest in the defendant's stock will have different litigation incentives than a plaintiff who does not. Thus, a plaintiff's financial interest in the defendant can radically change the course of litigation.

This paper explores a model of litigation and settlement when the plaintiff can trade the stock of the defendant firm. The capital market is assumed to be semi-strong form efficient: all publicly available information is reflected in the stock price at every stage of the game.[3] Before filing suit, the plaintiff may take either a long position or a short position against the defendant. With a long position, the plaintiff would benefit if the defendant's

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[1] Consider, for example, the class action lawsuit brought by a subset of Facebook's shareholders for an alleged overpricing of the new stock issued in the 2012 initial public offering. See, e.g., *In re Facebook, Inc., IPO Securities and Derivative Litigation*, 288 F.R.D. 26 (S.D.N.Y. 2012). Securities and Exchange Commission Rule 10b-5, promulgated pursuant to § 10(b) of the Securities Exchange Act of 1934, is a general anti-fraud rule that prohibits the use of manipulative or deceptive practices in connection with the purchase or sale of any security. See 15 U.S.C. 78j(b) (2012) (Section 10(b) of the Securities Exchange Act of 1934); 17 C.F.R. 240.10b-5 (2015) (Rule 10b-5). Under Rule 10b-5, investors can recover the difference between what they paid for the security and the price that they would have paid absent the violation (e.g., material misrepresentation). See, e.g., *Halliburton Co. v. Erica P. John Fund, Inc.*, 134 S. Ct. 2398 (2014) (Rule 10b-5 claim in class action lawsuit); *Basic Inc. v. Levinson*, 485 U.S. 224 (1988) (same). If such investors remain as shareholders at the time of the suit, while receiving direct recovery from the firm, the value of their shares will decrease due to the lawsuit. They can, of course, liquidate their position before bringing the suit, in which case their financial position would be neutral at the time of the lawsuit. There are other examples outside the securities context where plaintiffs have a "long" position on the defendant. A partner, who is entitled to a share of the partnership's profit, can bring an action against the partnership for monetary damages, for instance, for denying her the management right. See Revised Uniform Partnership Act Section 401(f) ("each partner has equal rights in the management and conduct of the partnership business"). Similarly, in a trusts and estates setting, a beneficiary who is entitled to distributions from a trust can also be a plaintiff against the trust. When the distribution is subject to the trustee's discretion, for instance, a beneficiary can bring suit against the trust (and the trustee) seeking a larger distribution to herself. See *Marsman v. Nasca*, 573 N.E.2d 1025 (Mass App. Ct. 1991).

[2] In an article in the Wall Street Journal, Walker and Copeland (2015) describe the short-and-sue tactics and controversy surrounding hedge-fund manager Kyle Bass' lawsuits against publicly-traded pharmaceutical companies. Mr. Bass is well known for predicting—and profiting from—the collapse of the subprime mortgage-backed securities market in 2007. By purchasing credit default swaps, Mr. Bass was in essence betting against or "shorting" the subprime bond market.

[3] More precisely, when the plaintiff attempts to take a financial position in the market, the market incorporates all relevant information about the impending litigation into the price, i.e., the plaintiff's private information (about the impending litigation) gets fully revealed through its trade. We can think of this as a strong version of the semi-strong form efficiency. This assumption will be relaxed in Part 3.

stock price goes up, and with a short position the plaintiff would benefit if the defendant's stock price falls. By selling the stock short, the plaintiff is actively betting against the firm, and will reap higher financial gains when the defendant suffers greater litigation losses. We show that when the capital market is semi-strong form efficient, the plaintiff does not capture any systematic direct benefit from the financial position. However, the plaintiff may secure indirect strategic benefits because, by the time of settlement or trial, the initial expenditure the plaintiff has incurred in taking the financial position is sunk and the plaintiff has an interim incentive to maximize the aggregate return from both litigation and the financial position.

The basic idea can be demonstrated with a simple example. Suppose the value of the defendant firm is \$100 without any litigation. If a plaintiff files suit against the firm, the plaintiff's expected recovery is \$10 but the cost of litigation is \$20 for the plaintiff and \$20 for the defendant firm. Obviously, the lawsuit has a negative expected value and, without additional incentive, the plaintiff will not file suit. Now suppose, before filing suit, the plaintiff takes a strong short position against the defendant at the initial firm value of v_0, so that, if the firm value later becomes v_1, the plaintiff realizes a financial return of one-half of the valuation difference: $(1/2)(v_0 - v_1)$. Suppose the lawsuit has been filed and the plaintiff must decide whether to proceed to trial or to drop the case. If she were to drop the case, the firm value becomes \$100 and she realizes a financial return of $(1/2)(v_0 - \$100)$. If she were to proceed to trial, on the other hand, firm value becomes \$70 and she realizes $(\$10 - \$20) + (1/2)(v_0 - \$70)$. Comparing the two returns, by proceeding to trial, she realizes an additional financial return of $(1/2)(\$100 - \$70)$, which is enough to make up for the loss of \$10 from trial.[4] By shorting the defendant's stock, the plaintiff has turned a non-credible threat of lawsuit into a credible one. This, in turn, will allow her to extract a positive settlement from the defendant.[5]

We begin by analyzing a model with symmetric information, where the plaintiff, the defendant, and capital market know the relevant parameters of the model. As shown in the numerical example, by taking a short position in the defendant's stock, the plaintiff can

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[4] She will proceed to trial rather than drop the case if $(\$10 - \$20) + (1/2)(v_0 - \$70) \geq (1/2)(v_0 - \$100)$, which produces $(\$10 - \$20) + (1/2)(\$100 - \$70) \geq 0$.

[5] When the financial market fully expects this, the plaintiff will make no positive financial return but she will still receive a direct, positive return from the lawsuit. Suppose the parties are expected to (and will) settle at \$20. When the case settles, the stock value of the firm is $v_1 = 80$. When the plaintiff shorts the stock, the financial market expects this future outcome and sets $v_0 = \$80$. When they settle at \$20, the plaintiff's financial return $(1/2)(v_0 - \$80)$ is zero but she receives a direct payment of \$20. If the financial market does not know about the existence of the lawsuit, and does not anticipate a future settlement, then the stock value of the firm would be $v_0 = \$100$ and the plaintiff would earn a financial return of $(1/2)(\$100 - \$80) = \$10$ in addition the \$20 from the settlement.

transform what would otherwise be a negative expected value claim into a positive expected value one. This, in turn, implies that more cases will be filed ex ante. While some of these claims may be meritorious and socially valuable, others may not be. Indeed, through a sufficiently short position, the plaintiff can credibly threaten to bring any suit to trial, even an entirely frivolous one where everyone agrees that the plaintiff's chances of prevailing in litigation are (near) zero. Short selling improves the plaintiff's bargaining power for positive expected value claims as well, leading to larger settlement payments by the defendant.[6] Conversely, when taking a long position in the defendant's stock, the plaintiff's threat to go to trial and bargaining position are compromised.

After presenting the basic results, we consider several extensions of the symmetric information model. We first relax the assumption of an efficient capital market, and imagine that the capital market is initially unaware of the lawsuit when the plaintiff takes the short position. In this case, the plaintiff can profit directly from the decrease in the stock price as well. Next, we show that our results hold when there are differential litigation stakes, where the defendant has more to lose from the lawsuit than the plaintiff stands to gain. We then show, in particular, that the loser-pays-the-costs rule can function as an effective screening device that keeps plaintiffs from accumulating financial positions to file frivolous claims. We then show that our results continue to hold when litigation costs are endogenous, and are chosen in a non-cooperative rent-seeking game. Finally, we show that our results are attenuated by the presence of plaintiff risk aversion.

We then extend the model to allow the defendant to be privately informed about the likely outcome at trial. In a screening protocol of Bebchuk (1984) and Nalebuff (1987) where the plaintiff makes a single take-it-or-leave-it offer, we show that the plaintiff's financial position has two basic effects. First, when credibility is not a concern, taking a short (long) position makes the plaintiff more (less) aggressive in his settlement offer. With a short position, for instance, a larger settlement produces an additional financial return. Thus, a short position will lead to more trials and fewer settlements. Second, when credibility is a concern, as in Nalebuff (1987), the plaintiff's financial position will change the plaintiff's interim incentive to drop the case. A short financial position relaxes the credibility constraint. Interestingly, this allows the plaintiff to become less aggressive and lower the settlement offer. In equilibrium, the plaintiff's optimal short position can benefit the defendant and lower the equilibrium rate of litigation.

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[6] The most that the defendant is willing to pay in settlement reflects the amount that the defendant expects to lose, on average, if the case goes to trial (expected damages plus the defendant's litigation costs).

We also examine the signaling protocol of Reinganum and Wilde (1987) where the informed defendant makes a take-it-or-leave-it settlement offer to the plaintiff. In the fully separating perfect Bayesian equilibrium, the defendant's settlement offer perfectly reveals the defendant's type and the plaintiff randomizes between accepting the offer and going to trial. The plaintiff's financial position has two basic effects. By taking a short position, the plaintiff induces the defendant to make a more generous settlement offer. This is a positive effect for the plaintiff ex ante. However, the short position also decreases the likelihood that the plaintiff will accept the defendant's offer to settle at the interim stage. This effect hurts the plaintiff in an ex ante sense. The plaintiff's optimal short position balances these two effects. Compared to a world that prohibits financial investing (taking a short position, in particular), the defendant is worse off and the litigation rate is higher.

As mentioned earlier, the possibility that plaintiffs may short the rival's stock is relevant in current litigation practice. The America Invents Act went into effect in September 2012.[7] Among other things, this Act provides a streamlined procedure under which just about anyone can challenge the validity of a patent by filing an inter partes review (IPR) petition before the United States Patent and Trademark Office.[8] One of the many IPR petitioners is hedge fund manager Kyle Bass.[9] Through one venture, the Coalition for Affordable Drugs, Mr. Bass has been challenging pharmaceutical patents in an arguably noble attempt to bring down prescription drug prices.[10] His critics maintain that Mr. Bass' motives are mercenary, and that Bass has been "betting against, or shorting, the shares of drug makers and biotechs whose patents he maintains are spurious."[11] At least one pharmaceutical company, Celgene, argued that Mr. Bass' IPR petitions should be dismissed as a sanction for misconduct, suggesting that he is using "the IPR process for the purpose of affecting the value of public companies. This is not the purpose for which the IPR process was designed."[12]

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[7] The Act is also called Leahy-Smith America Invents Act after the lead sponsors, Senator Patrick Leahy and Representative Lamar Smith. The Act was signed into law by President Obama on September 16, 2011.

[8] An inter partes review is a trial proceeding conducted before the U.S. Patent and Trademark Office (PTO) by the Patent Trial and Appeal Board (PTAB) to review the issues of patentability and the validity of patent. See 35 U.S.C. §§ 311–319. The parties bringing inter partes review (IPR) challenges need not have been themselves sued for patent infringement. Due partly to the ease with which such a claim could be filed, since the act went into effect in 2012, more than 4,470 petitions have been filed. See http://www.uspto.gov/patents-application-process/appealing-patent-decisions/statistics/aia-trial-statistics for January 2016 statistics.

[9] See Walker and Copeland (2015).

[10] Challenged patents include Ampyra (Acorda Therapeutics), Xyrem (Jazz Pharmaceuticals), Gattex (NPS Pharmaceuticals), Lialda (Shire), Imbruvica (Pharmacyclics, Inc. and Janssen Biotech, Inc.), Tecfidera (Biogen), and Revlimid (Celgene). See http://www.pharmapatentsblog.com/2015/05/05/keeping-up-with-kyle-bass/.

[11] Silverman (2015).

[12] In email correspondence dated June 3, 2015 with the PTAB, which is an addendum to a court order authorizing a motion for sanctions, pharmaceutical company Celgene suggests that Bass' venture and the other petitioning entities (collectively, the Real Parties in Interest or "RPI") is using "the IPR process for the purpose

This paper contributes to the literature on the economics of settlement of litigation in several ways.[13] We provide a new explanation for nuisance litigation, where unscrupulous plaintiffs extort money from otherwise blameless defendants by threatening them with litigation. At first blush, it might appear that a plaintiff with a negative expected value (NEV) claim could not possibly succeed in extracting a settlement offer: since a rational plaintiff would drop the NEV case before trial, a savvy defendant should rebuff the plaintiff's demands. Bebchuk (1988) and Katz (1990) argue that when the plaintiff is privately informed about the strength of his or her case, then extortion may succeed. In a complete information environment, Bebchuk (1996) shows that NEV claims may succeed if the costs are borne gradually over time and negotiations can take place after some but not all of the costs are sunk.[14] None of these papers recognize that financial transactions and short selling can transform a NEV claim into a positive expected value one.

Several papers in the law and economics literature explore how contracts with third parties can strengthen a litigant's bargaining position, leading to a more advantageous settlement. Meurer (1992) argues that an insurance contract can make a defendant tougher in

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of affecting the value of public companies. This is not the purpose for which the IPR process was designed. Moreover, one or more of the identified RPI previously threatened to file IPRs against the challenged patents unless Celgene met their demands. When Celgene did not pay, the RPI—apparently in furtherance of their efforts to abuse the IPR process for private financial gain—filed the present petitions." See Case IPR2015-01092 (Patent 6,045,501); Case IPR2015-01096 (Patent 6,315,720); Case IPR2015-01102 (Patent 6,315,720); and Case IPR2015-01103 (Patent 6,315,720). One of the legal arguments raised by Celgene is that the RPI are "abusing the process," which is a claim based on the regulatory authority of the PTO to prescribe "sanctions for...abuse of process, or any other improper use of the [IPR] proceeding," 35 U.S.C. § 316(a)(6), and the enforcement authority of the PTAB to impose sanctions, such as dismissal of the IPR petition, 37 C.F.R. § 42.12. Because the PTO has not defined the elements required to establish an "abuse of process" or an "improper use of the proceeding," Celgene relied on opinions and orders from federal courts and agencies that discussed the meaning of abuse of process in other contexts, including under common law tort principles. *See* Patent Owner Motion for Sanctions Pursuant to 35 U.S.C. § 316(a)(6) and 37 C.F.R. § 42.12, Case IPR2015-01092 (Patent 6,045,501) (citing, among other authorities, a U.S. Supreme Court case, *Heck v. Humprey*, 512 U.S. 477, 486 n. 5 (1994), which frames the gravamen of the tort as "some extortionate perversion of lawfully initiated processes to illegitimate ends"). [For a valid "abuse of process" claim, the moving party must show that (1) the counter party has an ulterior purpose or motive underlying the use of process, and (2) some act in the use of the legal process not proper in the regular prosecution of the proceedings. See *Cartwright v. Wexler, Wexler & Heller, Ltd.*, 369 N.E.2d 185, 187 (Ill. App. Ct. 1977).] [An alternative approach to the bracketed language above, which is based solely on Illinois state tort law: Generally, "[o]ne who uses a legal process, whether criminal or civil, against another primarily to accomplish a purpose for which it is not designed, is subject to liability to the other for harm caused by the abuse of process." Restatement (Second) of Torts § 682 (1979). The specific elements of this tort, like any other tort, vary by jurisdiction. *See, e.g.*, *Nader v. Democratic Nat'l Comm'n*, 567 F.3d 692, 697–99 (D.C. Cir. 2009) (discussing scope of "abuse of process" under tort law in District of Columbia); *Cartwright v. Wexler, Wexler & Heller, Ltd.*, 369 N.E.2d 185, 187 (Ill. App. Ct. 1977) (outlining elements for valid "abuse of process" claim under tort law in Illinois).]

[13] Early papers in this literature include Landes (1971), Posner (1973), and Gould (1973). See Cooter and Rubinfeld (1989), Daughety (2000), Daughety and Reinganum (2005), and Spier (2007) for surveys.

[14] Rosenberg and Shavell (1985) show that negative expected value (NEV) cases may succeed if the defendant must spend money on his or her defense in order to avoid an adverse summary judgment.

settlement negotiations, and may induce the plaintiff to lower the settlement demand. Spier and Sykes (1998) show that financial leverage may be an advantage to a corporate defendant in "bet-the-firm" litigation. While small judgments will be borne by the shareholders, a very large judgment might ultimately be borne by debt-holders in the resulting bankruptcy. Similarly, contingent fees can potentially make plaintiffs tougher in negotiations. By paying the lawyer the same contingent percentage whether the case settles or goes to trial, a plaintiff may be able to raise his or her minimum willingness to accept in settlement. This is because the lawyer is bearing the costs of litigation, not the plaintiff, making trial relatively more attractive (Choi, 2003; Bebchuk and Guzman, 1996). Spier (2003a, 2003b) and Daughety and Reinganum (2004) show how most favored nations clauses with early litigants can be a strategic advantage in negotiating with later ones.

A small number of papers, primarily in the industrial organization and finance literatures, have examined the possibility of taking a financial position in one's competitors. Gilo (2000) and Gilo, Moshe, and Spiegel (2006) argue that firms taking long financial positions in competitors in the same industry will have a decreased incentive to engage in vigorous competition and an increased incentive to engage in price collusion. Hansen and Lott (1995) argue that an incumbent firm's short position against a potential entrant will allow the incumbent to more successfully engage in costly predation should entry occur. Tookes (2008) shows how informed financial traders have an incentive to make information-based trades in the stocks of competitors and empirically shows an increase in intra-day transactions over competitors when one company makes an earnings announcement.[15] In a paper more directly related to ours, Kobayashi and Ribstein (2006) present a simple model where a plaintiff's lawyer can short the stock of the defendant and argue that allowing the lawyer, who receives a fraction of the recovery, to short the defendant's stock can mitigate the (litigation effort) incentive problem between the lawyer and the plaintiff.[16]

The paper is organized as follows. Part 1 includes the basic model setup. We present a game with two players (a plaintiff and a defendant) and a financial market that efficiently processes all public information. Part 2 analyzes the case of symmetric information, exploring the effects of financial position (long or short) on the credibility of suit and the outcome of bargaining, and characterizing the plaintiff's optimal short financial position. Part

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[15] Ayres and Choi (2002) call this type of behavior as "outsider trading" and propose giving right to the traded firm to decide whether to allow such outsider trading. The goal of the proposal is to make the traders "internalize" the potential harm caused by outsider trading.

[16] In their model, all the legal decisions (whether to file, settle, or proceed to trial) are made by the lawyer. They assume a weaker version of market efficiency so that the lawyer realizes a positive return from the financial position. They also do not consider the issues of credibility or asymmetric information. See also the informal discussion in Yahya (2006).

3 extends the basic symmetric information model to consider a capital market that is initially unaware of the lawsuit, differential stakes, alternative rules for allocating the costs of litigation, endogenous litigation spending, and risk aversion. Parts 4 and 5 allow the defendant to be privately informed of the strength of the case (i.e., the probability of losing at trial) and analyze the plaintiff's optimal financial position. Part 4 considers the screening protocol where the plaintiff makes a take-it-or-leave-it settlement offer to the defendant. Part 5 considers the signaling protocol where the defendant makes a take-it-or-leave-it settlement offer to the plaintiff. Part 6 concludes. Proofs that are omitted from the text are presented in the Appendix.

1. The Model

Consider a game with two risk-neutral players: a plaintiff (p) and a firm-defendant (d). The plaintiff has a legal claim against the firm-defendant. If the case goes to trial, the court finds in favor of the plaintiff and awards damages of $D > 0$ with probability $\pi \in [0,1]$, and the plaintiff and the defendant bear the litigation costs of $c_p > 0$ and $c_d > 0$, respectively. The firm owns and controls a set of assets that will generate a gross cash flow $R > 0$ where R is fixed and is sufficient to cover the damages award and the litigation cost, $R - D - c_d \geq 0$. So, bankruptcy is not a consideration. In the next section, we assume that all of these parameters are common knowledge. Later, we extend the model and allow the defendant to have private information regarding π.

The firm-defendant is capitalized with one class of stock (e.g., common stock) and there is a capital market at which the firm's stock trades. The firm's equity market capitalization at the beginning of a given period t can be represented by v_t. Note that v_t represents the firm's total equity market capitalization rather than its stock price.[17] We assume that the firm's debt and other financial obligations are all netted out from the analysis. The stock market is assumed to be rational and forward-looking, incorporating all information into the stock price at every stage of the game. We assume that the stock market is sufficiently liquid and the volume of trade is sufficiently large so that the plaintiff can fine-tune its financial position in the firm-defendant. There are four periods in the game with no time discounting: $t \in \{0,1,2,3\}$.

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[17] For instance, if there are 10,000 shares of common stock outstanding, each share will be worth $v_t/10{,}000$ at t.

At $t = 0$, the plaintiff takes a financial position in the firm-defendant that is equivalent to acquiring a proportion Δ of the firm-defendant's equity. For simplicity, we assume that, prior to $t = 0$, the plaintiff has no financial position in the defendant. The plaintiff's position can be either long ($\Delta > 0$) or short ($\Delta < 0$) and will be held until the end of the game ($t = 3$).[18] We assume that the plaintiff's financial position (Δ) is observed by the firm-defendant and by the capital market. Given that the stock market incorporates all relevant information, when the plaintiff acquires the Δ position on the defendant-firm, the firm valuation (v_0) will reflect the market's rational expectations about future settlement and litigation.[19] Since the firm valuation depends, foremost, on the plaintiff's financial position, we'll adopt the notation $v_0(\Delta)$. We will see later that v_0 and Δ are positively related; when the plaintiff takes a short position, $v_0(\Delta)$ falls. Finally, there may be limits on the position that the plaintiff can take: $\Delta_L \leq \Delta \leq \Delta_H$ where $\Delta_H \in (0, \infty)$ and $\Delta_L \in (-\infty, 0)$. If the plaintiff is indifferent between $\Delta = 0$ and other positions, we break indifference by assuming that the plaintiff chooses the neutral position $\Delta = 0$.

At $t = 1$, the plaintiff files suit and approaches the defendant in an attempt to negotiate an out-of-court settlement. In the next section, the parties share all relevant information, including the plaintiff's financial position, so all negotiations take place under complete information. For the symmetric information setting, we adopt the Nash bargaining solution concept where $\theta \in (0,1)$ denotes the defendant's relative bargaining strength, conditional on the plaintiff having a credible lawsuit. That is, θ is the share of the bargaining surplus that is captured by the defendant, when the plaintiff is willing to proceed to trial upon breakdown of settlement negotiations. As θ becomes higher (lower), the settlement amount (s) will tend to move in the defendant's (plaintiff's) favor.[20] Later, in the asymmetric information settings, we allow either the plaintiff or the defendant to make a take-it-or-leave-

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[18] In addition to trading directly on the stock, we allow for taking derivative positions. For the short position, for instance, the plaintiff can use various strategies, including short selling (under which the plaintiff borrows and sells a number of shares with a promise to return those shares in the future) or purchasing put options (which allows the plaintiff to sell the firm's stock at a pre-determined strike price). Similarly, for the long position, the plaintiff can also purchase a call option. Allowing derivative positions will expand the range of feasible financial positions, i.e., increase Δ_H and decrease Δ_L.

[19] This is a fairly strong condition that makes taking the financial position less attractive for the plaintiff. We will see in Part 3, however, that relaxing this assumption will not affect the main analysis. We will also be more precise about the implication of this assumption in terms of firm valuation.

[20] Equivalently, we can (1) interpret θ as the probability that the defendant makes a take-it-or-leave-it offer to the plaintiff and $1 - \theta$ as the probability that the plaintiff makes such an offer; and (2) structure the negotiation process as one party making the offer and, if the offer is not accepted, the plaintiff can decide whether to drop the case. In that setting, when the plaintiff does not have a credible case, the defendant will offer to settle at zero and will refuse to accept any plaintiff's offer unless the offer is zero.

it offer to the other. If the settlement negotiations break down, the plaintiff has the option to drop the case and avoid going to trial.

If the parties fail to settle at $t = 1$ and the plaintiff does not drop the case, then the case goes to trial at $t = 2$. With probability $\pi \in [0,1]$ the court finds in favor of the plaintiff and awards damages of D, and the respective litigation costs of c_p and c_d are borne. Thus, in expectation, the defendant would lose $\pi D + c_d$ and the plaintiff would gain $\pi D - c_p$ (which may be negative or positive) from the trial.

At time $t = 3$ the plaintiff's financial position is settled.[21] The plaintiff's net return from the financial position is $(v_3 - v_0(\Delta))\Delta$.[22] As it will become clear shortly, while the initial firm value depends on the plaintiff's financial position ($v_0(\Delta)$), by the end of the game, the firm value no longer depends on the plaintiff's position (v_3). Note that when the plaintiff takes a long position, $\Delta > 0$, the plaintiff secures a higher net return when the defendant's market valuation rises. When the plaintiff shorts the defendant's stock, $\Delta < 0$, the plaintiff receives a higher net return when the defendant's market valuation goes down.

In terms of the information structure, the basic components of this model—the presence of the plaintiff, the damages, the litigation costs, and the cash flows—are assumed to be common knowledge between the players and also for the investors in the stock market. The plaintiff seeks to maximize its profits, which will include both the returns from litigation as well as any returns from the financial investment. As is standard in the literature, and in keeping with the fiduciary obligations under the corporate law, the firm seeks to maximize firm profits or, equivalently, its market valuation. The solution concept is subgame-perfect Nash equilibrium, and we will solve this model by backward induction.

2. Symmetric Information

The market valuation of the firm at any given point in time depends on the expectations formed by the rational investors in the stock market, incorporating all publicly

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[21] The assumption that the plaintiff always settles its financial position at $t = 3$ streamlines the exposition but is not critical to the results.

[22] To see why this is true, suppose that the plaintiff took a long position ($\Delta > 0$) in the defendant's stock at $t = 0$, paying $v_0(\Delta)\Delta$ for a proportion Δ of the defendant's equity. If the market valuation changes to v_3, the plaintiff nets $(v_3 - v_0(\Delta))\Delta$. Now suppose instead that the plaintiff took a short position in the defendant's stock ($\Delta < 0$), borrowing proportion $|\Delta|$ of the firm's equity, sells the borrowed stake for $v_0(\Delta) \cdot |\Delta|$, and deposits the money in a brokerage account at $t = 0$. The plaintiff is then obligated to return the borrowed shares to the lender in the future. If the future valuation is v_3, the plaintiff nets $v_0(\Delta) \cdot |\Delta| - v_3 \cdot |\Delta| = (v_3 - v_0(\Delta))\Delta$.

available information. Specifically, the firm's valuation at the end of the game depends critically on how the lawsuit was resolved in the earlier periods, namely whether the case was (1) settled, (2) dropped, or (3) litigated. We will now characterize those values.

First, suppose the case settles for s at $t = 1$. Settlement brings finality to the litigation proceedings, and avoids further expenditures on litigation. So, following a settlement, the value of the firm-defendant will be $v_2 = v_3 = R - s$, the value of the firm's assets, R, minus the settlement payment to the plaintiff, s. Second, suppose that the plaintiff drops the case at the end of $t = 1$. This also ends the lawsuit, and so $v_2 = v_3 = R$. Third, if the case goes to trial at $t = 2$ and the plaintiff subsequently wins damages D, then $v_3 = R - D - c_d$. If the case goes to trial at $t = 2$ and the plaintiff loses the case then $v_3 = R - c_d$. Taken together, if the parties fail to settle and the plaintiff does not drop the case, the valuation of the firm immediately before trial at the beginning of $t = 2$ reflects the market's expectation of the firm's future value, $v_2 = R - \pi D - c_d$.

2.1. The Credibility of Suit

Suppose that the plaintiff and the defendant have reached a bargaining impasse. Will the case go to trial, or will the plaintiff drop the case? In the standard model of settlement, the plaintiff has a credible commitment to take a case to trial when the expected damages exceed the litigation cost, or $\pi D \geq c_p$. In the current context, the plaintiff's drop decision will also depend on the plaintiff's financial stake in the defendant's stock.

Suppose that the plaintiff acquired the position Δ at valuation v_0 at time zero. Since the firm's valuation will be equal to $v_3 = R$ if the plaintiff subsequently drops the case, the plaintiff's payoff from dropping the case is $(v_3 - v_0(\Delta))\Delta = (R - v_0(\Delta))\Delta$. If the plaintiff takes the firm-defendant to trial instead, the expected value of the firm's stock will be equal to $v_2 = R - \pi D - c_d$, and so the plaintiff's expected payoff from trial is $\pi D - c_p + (R - \pi D - c_d - v_0(\Delta))\Delta$. Comparing these two expressions, the plaintiff will choose to go to trial rather than drop the case when

$$\pi D - \Delta (\pi D + c_d) \geq c_p \tag{1}$$

The plaintiff has a credible case when the expected damage award plus any financial gain from the decline in the defendant's stock value is greater than the plaintiff's cost of litigation.[23] Rearranging terms gives the following result.

Lemma 1. *The plaintiff has a credible threat to go to trial if and only if the plaintiff's financial position is $\Delta \leq \tilde{\Delta}$ where:*

$$\tilde{\Delta} = \frac{\pi D - c_p}{\pi D + c_d} < 1 \tag{2}$$

From the expression, we can see that, conditional on $\tilde{\Delta}$, litigation credibility is weakened when the plaintiff takes a long position. If $\Delta = 1$, for instance, so the plaintiff's payoff reflects 100% of the firm's equity, the plaintiff would never want to bring the case to court: the lawsuit will have no credibility. By suing the defendant, the plaintiff would essentially be transferring money from one pocket to the other, while wasting money on litigation costs. Credibility is enhanced, however, when the plaintiff takes a short position against the defendant firm. By shorting the defendant's stock, the plaintiff can augment the damages award with the gain from the reduction in the defendant firm's stock value. Even if the lawsuit itself has a negative expected value, i.e., $\pi D - c_p < 0$, the plaintiff can gain credibility by taking a sufficiently large short position: $\Delta \leq \tilde{\Delta} < 0$. As an extreme case, even when the plaintiff has no chance of winning whatsoever (so $\pi = 0$), the plaintiff can establish credibility by setting $\Delta \leq \tilde{\Delta} = -c_p/c_d$. In short, any lawsuit—even a completely frivolous one with $\pi = 0$—can become credible if the plaintiff takes a sufficiently large short position in the defendant's stock.

2.2. Bargaining Outcome

Suppose the plaintiff has a financial position $\Delta \leq \tilde{\Delta}$, so the plaintiff has a credible threat to bring the case to trial. This will in turn allow the plaintiff to extract a positive settlement offer from the defendant. We will now characterize the outcome of the settlement bargaining game.

The firm-defendant, seeking to maximize shareholder value, would be willing to accept a settlement offer s that satisfies $R - s \geq R - \pi D - c_d$. Thus, the most that the

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[23] Note that this condition does not depend on the firm's initial valuation, $v_0(\Delta)$. The value $v_0(\Delta)$ is irrelevant since the plaintiff's financial transactions at $t = 0$ are sunk at the time that the plaintiff is making its drop decision at $t = 1$. The credibility of the threat does not depend on R because we assumed that the firm's asset value is sufficient to cover any possible adverse judgment at trial (no bankruptcy).

defendant is willing to pay, $\bar{s}$, is the expected damage award plus the defendant's litigation cost:

$$\bar{s} = \pi D + c_d \tag{3}$$

This expression is familiar from standard settlement models and does not depend on the plaintiff's financial position.

Now consider the plaintiff. If the case goes to trial, the plaintiff's expected payoff is $\pi D - c_p + (R - \pi D - c_d - v_0(\Delta))\Delta$, the expected damage award minus the litigation cost plus the plaintiff's net expected profit from the financial investment. If the case settles for s then the plaintiff's payoff is $s + (R - s - v_0(\Delta))\Delta$. Setting these expressions equal to each other and rearranging terms, the least the plaintiff is willing to accept is:

$$\underline{s}(\Delta) = \pi D + c_d - \left(\frac{c_p + c_d}{1 - \Delta}\right) \tag{4}$$

The plaintiff's bargaining position depends critically on the plaintiff's financial stake, Δ. If the plaintiff takes a neutral financial position in the firm, $\Delta = 0$, then the minimum the plaintiff must receive to settle the case is $\pi D - c_p$ as in the standard model of settlement of litigation. When the financial position is negative ($\Delta < 0$) then $\underline{s}(\Delta)$ rises above $\pi D - c_p$ and the plaintiff's bargaining power is enhanced. The reason for this is straightforward. With a short position on the defendant, by going to trial, the plaintiff not only gets the recovery from judgment but also additional financial return from the short position. The stronger the short position, the more the plaintiff must receive to settle. In the limit, as Δ approaches negative infinity, the least that the plaintiff is willing to accept in settlement converges to $\pi D + c_d$, which is the most that the defendant is willing to pay.

Comparing (3) and (4) we see that $\underline{s}(\Delta) < \bar{s}$, so a positive bargaining range exists.[24] Recalling that parameter $\theta \in (0,1)$ be the bargaining power of the defendant, we find that so long as $\Delta \leq \tilde{\Delta}$ the case would settle for $s(\Delta) = (1 - \theta)\bar{s} + \theta\underline{s}(\Delta)$. We have the following result.

Proposition 1. *Suppose the plaintiff takes financial position Δ at $t = 0$. If $\Delta \leq \tilde{\Delta}$, the case settles out of court for $s(\Delta) = \pi D + c_d - \theta\left(\frac{c_p + c_d}{1 - \Delta}\right) > 0$. $s'(\Delta) < 0$ and $\lim_{\Delta \to -\infty} s(\Delta) = \pi D + c_d$. If $\Delta > \tilde{\Delta}$, the case is dropped.*

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[24] Note that $\underline{s}(\tilde{\Delta}) = 0$ and $\underline{s}(\Delta)$ rises as Δ falls.

2.3. The Plaintiff's Choice of Financial Position

We now construct the equilibrium financial position taken by the plaintiff. At $t = 0$ when the plaintiff takes the financial position Δ, the capital market rationally anticipates whether (1) the parties will settle their case out of court; (2) the parties will fail to settle but the plaintiff will drop the case; or (3) the parties will fail to settle and the case will proceed to trial. The firm valuation $v_0(\Delta)$ will be determined in accordance with the capital market's rational expectations.

With a fully rational stock market, the plaintiff makes no return from its financial position. A short financial position benefits the plaintiff in two ways, however. First, it can turn a negative expected value case into a positive expected value one. This allows the plaintiff to credibly threaten the firm that it will take the case to trial, and thereby allows the plaintiff to extract a positive settlement offer. Second, short selling can shift the bargaining outcome in the plaintiff's favor by increasing the minimum that the plaintiff is willing to accept in settlement. This forces the defendant to pay more to the plaintiff to settle the case.

Proposition 2. *Suppose* $\Delta_L \leq \tilde{\Delta} < 1$. *In equilibrium, the plaintiff takes as large a short position as possible against the defendant* $(\Delta = \Delta_L < 0)$ *and the case settles out of court for* $s(\Delta_L) = \pi D + c_d - \theta\left(\frac{c_p + c_d}{1 - \Delta_L}\right) > 0$. *If* $\Delta_L > \tilde{\Delta}$, *the plaintiff chooses a neutral position* $(\Delta = 0)$ *and the case is dropped.*

Proof of Proposition 2. If $\Delta > \tilde{\Delta}$ then the plaintiff does not have a credible threat to take the case to trial (Lemma 1) and would therefore drop the case. The capital market expects that the lawsuit will ultimately be dropped so that $v_0(\Delta) = v_3(\Delta) = R$ and the plaintiff's payoff is equal to zero. If $\Delta \leq \tilde{\Delta}$, then the plaintiff has a credible threat to take the case to trial. The capital market anticipates a settlement at $s(\Delta)$ defined in Proposition 1 and so the stock value is $v_0(\Delta) = v_3(\Delta) = R - s(\Delta)$ and the plaintiff's payoff is $s(\Delta) + [v_3(\Delta) - v_0(\Delta)]\Delta = s(\Delta)$. Since $s'(\Delta) < 0$, from Proposition 1, the plaintiff's payoff $s(\Delta)$ is maximized by taking as short a position as it possibly can. When the plaintiff takes position $\Delta_L \leq \tilde{\Delta}$, the lawsuit is credible and the case settles for $s(\Delta_L)$. ∎

According to Proposition 2, the plaintiff will take the shortest possible position Δ_L at $t = 0$. Because the stock market is fully rational and forward-looking, the market foresees that the parties will subsequently settle the case for $s(\Delta_L)$, and so the firm's market valuation immediately adjusts to $v_0(\Delta_L) = R - s(\Delta_L)$ and stays at that level along the equilibrium path. When the plaintiff liquidates its position at $t = 3$, since the market valuation hasn't changed,

the plaintiff makes no positive return from the financial position. Since a stronger short position increases the plaintiff's gross return from going to trial and getting a judgment, the defendant has to pay more to settle the case with the plaintiff. In equilibrium, therefore, all the additional return the plaintiff gets comes from the increase in bargaining power vis-à-vis the defendant through the financial position.

Note that the defendant cannot change its own bargaining position by taking a financial position in its own stock. To see why, suppose that the defendant took position γ at the beginning of the game. If the defendant were to settle, the defendant's payoff would be $R - s + (R - s - v_0(\Delta))\gamma$. If the defendant were to proceed to trial, the payoff would be $R - \pi D - c_d + (R - \pi D - c_d - v_0(\Delta))\gamma$. Comparing these two expressions, the defendant would prefer to settle when $s \leq \pi D + c_d$, which is independent of financial position γ. Hence, taking a financial position in its own stock cannot benefit the defendant. Why does the financial position create asymmetric effects on the litigants? This is coming from the fact that while the plaintiff earns $\pi D - c_p$ directly from litigation, the plaintiff's financial return from litigation depends on the defendant's loss, $\Delta(\pi D + c_d)$. Therefore, if the defendant wanted to neutralize or mitigate the financial effect, the defendant would need to take a financial position in the plaintiff's stock, if possible.[25]

3. Symmetric Information: Extensions

This section explores several extensions of the symmetric information model: (1) investors are initially unaware of the lawsuit, so that the stock price does not initially incorporate the plaintiff's financial position; (2) differential litigation stakes, where the return from litigation that the plaintiff gets differs from that for the defendant; (3) cost-shifting rules (English versus American rules) which may require the loser to pay the litigation cost of the winner; (4) endogenous litigation costs, where the amount of resources spent by the litigants depend on the litigation stakes; and (5) plaintiff risk aversion.

3.1 Capital Market is Initially Unaware of the Lawsuit

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[25] Even when the defendant were to take a financial position against the plaintiff's stock (assuming that this is possible), the plaintiff enjoys the first mover advantage and the defendant may not want to take too strong a position to eliminate the possibility of settlement. We saw that the plaintiff's reservation settlement value is $\underline{s}(\Delta) = \pi D + c_d - \left(\frac{c_p + c_d}{1 - \Delta}\right)$, which converges to $\pi D + c_d$ as $\Delta \to -\infty$. When the defendant takes a financial position of γ against the plaintiff's stock, the maximum settlement offer the defendant would be willing to make can be written as $\overline{s}(\gamma) = \pi D - c_p + \left(\frac{c_p + c_d}{1 - \gamma}\right)$, which converges to $\pi D - c_p$ as $\gamma \to -\infty$. Clearly, when γ gets too small, we get $\overline{s}(\gamma) < \underline{s}(\Delta)$, settlement breaks down, and the defendant expects to lose $\pi D + c_d$ at trial.

The previous analysis has assumed that when the plaintiff takes the financial position of Δ at $t = 0$, the stock price instantly incorporates that information, and that the plaintiff amasses the position at firm value $v_0(\Delta)$. For instance, per Proposition 2, if the plaintiff were to take the maximal short position against the defendant ($\Delta = \Delta_L$) at $t = 0$ and the suit were to settle at $s(\Delta_L)$ at $t = 1$, given that the market fully expects such outcome, the plaintiff's short position is executed at the firm value of $v_0(\Delta_L) = R - s(\Delta_L)$ and the plaintiff did not make any return from the financial position.

The assumption that the stock price instantly incorporates the plaintiff's financial position when and as the plaintiff accumulates the position may be too strong. In reality, the plaintiff may be able to take on a position (anonymously) without the financial market immediately realizing the implications. In other words, the plaintiff's financial position may come as an arrival of new information to the market only after the market becomes aware of the plaintiff's position.

To reflect this possibility, suppose the plaintiff gets to take on a financial position Δ at $t = 0$ at the defendant firm value of $v_0 = R$. Note that, unlike before, v_0 is independent of Δ. From $t = 1$ and on, however, the market is assumed to be fully rational as before. Note that the results in Lemma 1 and Proposition 1 are independent of the initial value of the firm v_0. First, regardless of v_0, the credibility threshold of $\widetilde{\Delta} = \frac{\pi D - c_p}{\pi D + c_d} < 1$ is independent of v_0. Second, the plaintiff will have a credible case if $\Delta \le \widetilde{\Delta}$ and, with a financial position of $\Delta \le \widetilde{\Delta}$, the case will settle for $s(\Delta) = \pi D + c_d - \theta\left(\frac{c_p + c_d}{1 - \Delta}\right) > 0$. The reason is that, by the interim stage ($t = 1$), the plaintiff's initial expenditure in amassing the financial position is sunk and the issues of credibility and the settlement amount depend only on the future outcomes of litigation and the future stock price.

Hence, allowing the plaintiff to take on a financial position at $t = 0$ without affecting firm value will increase the total return the plaintiff will be able to enjoy without affecting the main outcome. For instance, when the plaintiff has a credible case, from $t = 1$ and on, the financial market rationally expects the parties to settle at $s(\Delta)$ and we get $v_1(\Delta) = v_3(\Delta) = R - s(\Delta)$. When the parties indeed settle at $s(\Delta)$, the plaintiff's payoff becomes $s(\Delta) + [v_3(\Delta) - v_0]\Delta$. So long as $v_3(\Delta) < v_0$, taking a short position against the defendant will increase the plaintiff's total return.

Per Proposition 2, if the plaintiff were to take the maximum possible short position of $\Delta = \Delta_L < 0$, where $\Delta_L \le \widetilde{\Delta} < 1$, the plaintiff's return becomes $s(\Delta_L) + [v_3(\Delta_L) - v_0]\Delta_L$

which is strictly larger than $s(\Delta_L)$ since $v_0 = R > R - s(\Delta) = v_3(\Delta_L)$. On the other hand, if $\Delta_L > \tilde{\Delta}$, the market expects the plaintiff to drop the case and $v_1(\Delta) = v_3(\Delta) = R$. The plaintiff, in equilibrium, does not take on any financial position on or bring suit against the defendant. In sum, when the financial market does not instantly incorporate the information from the plaintiff's financial position, assuming that the litigation becomes credible, the plaintiff will realize a positive payoff from both the litigation and the financial position. If litigation is not credible, the plaintiff makes no return from either the litigation or the financial position.

3.2 Differential Litigation Stakes

The analysis has so far assumed that the plaintiff and the defendant have the same fundamental stakes in litigation. If the court awards damages of D, then this amount is paid by the defendant and received by the plaintiff. In practice, the defendant firm's stakes may differ from the stakes of the plaintiff. For example, the benefit to a plaintiff from winning injunctive relief may be outweighed by the cost of the injunction to the defendant. Or, revisiting the example from the introduction, the benefit to a single plaintiff from succeeding with an inter partes review (IPR) in a patent challenge may be greatly outweighed by the losses to the firm when the floodgates open following the loss of patent protection. Indeed, if the plaintiff owns no competing patent, getting the defendant's patent to be declared invalid may produce no return for the plaintiff even though the invalidity declaration may be quite costly for the defendant.

Suppose that if the plaintiff wins the case, the plaintiff receives fraction $\lambda \in [0,1)$ of the damages paid by the defendant, D. Extending our previous analysis, the plaintiff has a credible threat to go to trial when the plaintiff's payoff from trial, $\lambda \pi D - c_p + (R - \pi D - c_d - v_0(\Delta))\Delta$, exceeds the payoff from dropping the case, $(R - v_0(\Delta))\Delta$, or

$$\Delta \le \tilde{\Delta}(\lambda) = \frac{\lambda \pi D - c_p}{\pi D + c_d} \tag{5}$$

Note that the credibility threshold $\tilde{\Delta}(\lambda)$ is increasing in λ, so credibility is easier (harder) to achieve when the plaintiff's direct stake in litigation is larger (smaller).

Now suppose that the plaintiff takes a position $\Delta \leq \tilde{\Delta}(\lambda)$ so that the plaintiff has a credible case. The most the defendant is willing to pay is $\overline{s}(\Delta; \lambda) = \pi D + c_d$, as before, but the least the plaintiff is willing to accept is now:[26]

$$\underline{s}(\Delta; \lambda) = \pi D + c_d - \left(\frac{1}{1 - \Delta}\right)[(1 - \lambda)\pi D + (c_p + c_d)] \tag{6}$$

When $\lambda < 1$, then plaintiff is in a weaker bargaining position vis-à-vis the defendant. However, in the limit as Δ approaches negative infinity, the lower bound $\underline{s}(\Delta; \lambda)$ converges to the upper bound, $\overline{s}(\Delta; \lambda) = \pi D + c_d$.

We have just seen that short selling is particularly valuable in environments where the plaintiff has little to gain from litigation but the defendant has a significant amount to lose. Strikingly, with short selling, the plaintiff can extract the full value $\pi D + c_d$ from the defendant in settlement even when the plaintiff's private litigation stake is zero ($\lambda = 0$). This illustrates how a hedge fund might successfully challenge the validity of a defendant's patent even when the capital market is efficient and the expected direct recovery from the litigation is negligible.

3.3 The Loser-Pays Rule for Allocating Legal Costs

The previous sections assumed that each side in litigation bears its own litigation cost, regardless of the trial outcome (the American Rule). In this section, we explore how the analysis changes with the English Rule, where the loser of litigation must pay for its own costs as well as the costs of the winner. With the English Rule, the plaintiff's expected return from trial is $\pi D - (1 - \pi)(c_p + c_d)$ while the expected loss for the defendant is $\pi D + \pi(c_p + c_d)$.

The plaintiff would prefer to go to trial rather than drop the case when the payoff from litigation, $\pi D - (1 - \pi)(c_p + c_d) + [R - \pi(D + c_p + c_d) - v_0(\Delta)]\Delta$, is larger than the plaintiff's payoff from dropping, $(R - v_0(\Delta))\Delta$, or

$$\Delta \leq \tilde{\Delta}(\pi) = \frac{\pi D - (1 - \pi)(c_p + c_d)}{\pi D + \pi(c_p + c_d)} \tag{7}$$

This credibility threshold, $\tilde{\Delta}(\pi)$, may be either larger or smaller than the threshold under the American Rule. When $\pi > c_d/(c_p + c_d)$ then credibility is easier to achieve under the

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[26] If the plaintiff accepts the firm's settlement offer then the plaintiff's payoff is $S + (R - S - v_0(\Delta))\Delta$. The plaintiff's payoff from going to trial is $\lambda \pi D - c_p + (R - \pi D - c_d - v_0(\Delta))\Delta$.

English Rule than the American Rule, and when $\pi < c_d/(c_p + c_d)$ then credibility is more difficult to achieve.[27] Note that if the case is entirely frivolous (in the sense that $\pi = 0$) then $\tilde{\Delta}(\pi)$ does not exist. There is no amount of short selling that can make the lawsuit credible.

Suppose the plaintiff has a credible threat to go to trial, $\Delta \leq \tilde{\Delta}(\pi)$. The most the firm is willing to pay to settle the case is $\bar{s}(\Delta; \pi) = \pi D + \pi(c_p + c_d)$ and the least that the plaintiff is willing to accept is

$$\underline{s}(\Delta; \pi) = \pi D + \pi(c_p + c_d) - \frac{c_p + c_d}{1 - \Delta} \tag{8}$$

One can easily show that the bounds on the bargaining range, $\bar{s}(\Delta; \pi)$ and $\underline{s}(\Delta; \pi)$, are smaller under the English Rule than the American Rule if and only if $\pi < c_d/(c_p + c_d)$. Furthermore, by shorting the defendant's stock, the plaintiff can increase $\underline{s}(\Delta; \pi)$, thereby improving its bargaining position. In the limit as Δ approaches negative infinity, $\underline{s}(\Delta; \pi)$ converges to $\bar{s}(\Delta; \pi)$ and the plaintiff extracts all of the bargaining surplus from the defendant.

We have just shown that when the plaintiff's case is weak (in the sense that $\pi < c_d/(c_p + c_d)$), the credibility will require a more significant short position under the English Rule than the American Rule and the most that the plaintiff can hope to gain in settlement is smaller. When the case is totally frivolous ($\pi = 0$), since the firm will not incur any loss through trial under the English Rule, the firm valuation will remain constant throughout at R. This implies that the plaintiff cannot make any financial return by shorting the defendant's stock and cannot successfully extract a settlement offer.[28] Thus, fee-shifting may be an effective policy instrument in preventing frivolous claims from going forward through financial maneuvering and limiting the amount of the settlements.

3.4 Endogenous Litigation Costs

We now extend the model to consider endogenous litigation costs using a standard Tullock (1980) contest framework.[29] Suppose that the costs of litigation c_p and c_d are choice

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[27] See Rosenberg and Shavell (1985) for related results in models without financial investing.
[28] Suppose the suit has some merit ($\pi > 0$) but the plaintiff's recovery is small or zero ($D = 0$). Under that scenario, even with the English Rule, the plaintiff can still turn a non-credible lawsuit into a credible one by taking a sufficiently large short position against the defendant.
[29] Others who have used contest models to study litigation include Posner (1973, appendix), Katz (1988), Farmer and Pecorino (1999), Parisi (2002), Bernardo et al. (2000), Prescott et al. (2014), and Rosenberg and Spier (2014).

variables for the parties at trial and are chosen simultaneously and non-cooperatively. The probability that the plaintiff wins at trial is

$$\pi(c_p, c_d) = \frac{c_p^r}{c_p^r + c_d^r} \tag{9}$$

where $0 < r \leq 1$. When $r = 1$, this contest is a so-called "lottery contest," where the likelihood that the plaintiff wins, $c_p/(c_p + c_d)$, corresponds to his or her share of the total dollars spent.

Conditional on financial position Δ, the plaintiff chooses c_p to maximize the net return from litigation and the financial investment, $\pi(c_p, c_d)D - c_p + [R - \pi(c_p, c_d)D - c_d - v_0(\Delta)]\Delta$, taking the defendant's expenditure c_d as fixed. The plaintiff's optimization problem is equivalent to $\max_{c_p} \pi(c_p, c_d)(1 - \Delta)D - c_p$. The defendant chooses c_d to maximize $R - \pi(c_p, c_d)D - c_d$, taking c_p as fixed, or equivalently $\max_{c_d} [1 - \pi(c_p, c_d)]D - c_d$. This standard contest model with asymmetric stakes has the following solution:[30]

$$c_p^* = \frac{(1-\Delta)^{1+r}}{[1+(1-\Delta)^r]^2} rD, \; c_d^* = \frac{(1-\Delta)^r}{[1+(1-\Delta)^r]^2} rD, \text{ and } \pi(c_p^*, c_d^*) = \frac{(1-\Delta)^r}{1+(1-\Delta)^r} \tag{10}$$

In equilibrium, $c_p^* = c_d^*(1 - \Delta)$. When the plaintiff takes the neutral financial position, $\Delta = 0$, then the plaintiff and defendant spend the same amount and the plaintiff wins half the time, $\pi(c_p^*, c_d^*) = 1/2$. The plaintiff and defendant are on a level playing field in this special case. When the plaintiff takes a short position ($\Delta < 0$), the plaintiff has more to gain from litigation than the firm has to lose, since the plaintiff would gain the financial return from the short sale as well as from the litigation expenditure. The probability that the plaintiff wins exceeds one half with short selling. In the limit as Δ approaches negative infinity, the probability that the plaintiff will prevail at trial $\pi(c_p^*, c_d^*)$ approaches one.

An analysis of this equilibrium, which may be found in the appendix, establishes the following. In this model with fully variable litigation expenditures, without any fixed costs, the plaintiff has a credible threat to take the defendant to trial for all values $\Delta < 1$. Nevertheless, through short selling, the plaintiff can gain a significant strategic advantage in this game. When Δ is negative and becomes larger in magnitude, the plaintiff's incentive to spend money increases since the plaintiff's stakes are larger than before. Facing a stronger

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[30] The equilibrium is characterized in the survey of Konrad (2009), page 45. Letting the plaintiff be contestant 1 and the defendant be contestant 2, c_p and c_d correspond to expenditures x_1 and x_2, respectively, and $\pi(c_p, c_d)$ and $1 - \pi(c_p, c_d)$ correspond to $p_1(x_1, x_2)$ and $p_2(x_1, x_2)$ in the standard notation. The stakes for the plaintiff and defendant, $(1 - \Delta)D$ and D correspond to v_1 and v_2 (in the standard notation).

opponent, the defendant will find itself on the backward bending part of the reaction curve, and will reduce its litigation expenditures in retreat. This will of course lead to a higher chance that the plaintiff will win the litigation. With a better expected outcome from trial, the plaintiff will be able to extract a better settlement outcome. In the limit as the short position approaches negative infinity, the defendant's expenditures approach zero and the plaintiff extracts D in settlement.

3.5 Plaintiff Risk Aversion

The previous sections assumed that the plaintiff was risk neutral, and evaluated the plaintiff's different options (drop, litigate, settle) at their expected value. We now relax that assumption, and show how plaintiff risk aversion will dampen the plaintiff's incentive to bring suit will reduce the plaintiff's bargaining power. We will also illustrate how risk aversion may reduce the benefits of a sue-and-short strategy, and may actually lead the plaintiff to take a long position in the defendant's stock.

To illustrate these ideas, suppose that the plaintiff's utility has a simple mean-variance form. Given financial position Δ, the plaintiff's certainty equivalent of going to trial is $\pi D - c_p + (R - \pi D - c_d - v_0(\Delta))\Delta - (1 - \Delta)^2\rho$, where ρ is the plaintiff's risk premium from going to trial with a neutral financial position ($\Delta = 0$).[31] Note when $\rho > 0$, then the plaintiff's risk premium is larger when the plaintiff's position is shorter, and taking a long position reduces the risk premium. The plaintiff has a credible threat to go to trial when this expression is larger than $(R - v_0(\Delta))\Delta$, or

$$\pi D - \Delta(\pi D + c_d) - (1 - \Delta)^2\rho \geq c_p$$

Comparing this expression to equation (1), it is obvious that credibility is harder to achieve than before. The risk premium makes going to trial less attractive for the plaintiff. Note also that when the plaintiff is very risk averse (ρ is large), then there may exist no financial position that achieves credibility. Thus, risk aversion may thwart a sue-and-short strategy.

Even if the plaintiff does have a credible threat to bring the lawsuit to trial, risk aversion will tend to weaken the plaintiff's bargaining position. The least the plaintiff is willing to accept makes the plaintiff indifferent between going to trial (which has an associated risk premium of $(1 - \Delta)^2\rho$) and settling out of court (which is safe). Comparing the alternatives, one can easily show that the least the plaintiff is willing to accept is

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[31] Letting a be the coefficient of absolute risk aversion, we have $\rho = (a/2)D^2\pi(1 - \pi)$. See the binary model and discussion in Prescott et al. (2014).

$$\underline{s}(\Delta) = \pi D + c_d - \left(\frac{c_p + c_d}{1 - \Delta}\right) - (1 - \Delta)\rho$$

Comparing this expression to equation (4), we see that $\underline{s}(\Delta)$ is lower that it was before, reflecting the riskiness of trial. It follows that when the bargaining parameter $\theta > 0$, the plaintiff will extract less in settlement than before. Finally, in contrast to our analysis without risk aversion, taking a shorter position is not always better for the plaintiff. There is a tradeoff: taking a shorter position makes the plaintiff tougher through the channel identified earlier, but also weakens the plaintiff through the risk premium. As a consequence, the optimal financial position will tend to be less short and, when the plaintiff is sufficiently risk averse, the optimal position may in fact be long.

4. Asymmetric Information: Screening

So far, we have assumed that the plaintiff, the defendant, and the capital market are symmetrically informed of all relevant aspects of the litigation, including the probability of plaintiff's winning at trial. We now relax this assumption and assume that the defendant privately observes the probability of being held liable, π, which is drawn from a probability density function $f(\pi)$. $f(\pi)$ is continuous and strictly positive on its support $[0,1]$, and $F(\pi)$ is the cumulative distribution function. We follow the standard screening protocol of Bebchuk (1984) and Nalebuff (1987) and assume that the uninformed plaintiff makes a single take-it-or-leave-it offer to the informed defendant at $t = 1$. If the defendant accepts the offer, the game proceeds to $t = 3$. If the defendant rejects the offer, the plaintiff can either drop the case or proceed to trial (at $t = 2$). The financial market is fully rational, and adjusts the firm valuation based on the new information, if any, that is revealed through settlement bargaining. Our solution concept is perfect Bayesian equilibrium.

Before analyzing this extension, let us briefly revisit the earlier case with *symmetric information* when the plaintiff has all of the bargaining power ($\theta = 0$). In this world, if $\pi D - c_p > 0$ then $\tilde{\Delta} > 0$ and so the case is credible when $\Delta = 0$. Short selling would be unnecessary in this scenario: the plaintiff would demand $\overline{s} = \pi D + c_d$, and the defendant would accept this offer. If the defendant refused, then the plaintiff would take him to court. If $\pi D - c_p < 0$, then $\tilde{\Delta} < 0$ and the plaintiff's threat to litigate is not credible when $\Delta = 0$. In this scenario, by taking a sufficiently short position—any value $\Delta \leq \tilde{\Delta}$ will do—the plaintiff will succeed in getting the defendant to pay $\overline{s} = \pi D + c_d$. Thus, when the plaintiff can make

a take-it-or-leave-it offer, short selling is valuable only for the purpose of establishing credibility.

Similarly, with *asymmetric information*, short selling is valuable when the plaintiff needs to relax the credibility constraint. With a sufficiently short position, the plaintiff can credibly threaten to go to trial should the settlement offer be rejected. Short selling is a double-edged sword, however. While relaxing the credibility constraint may be strategically valuable for the plaintiff, short selling will also distort plaintiff's settlement demand above its ex ante optimal level. Specifically, when the plaintiff has taken a short position, the plaintiff has an interim incentive to be more aggressive and raise the settlement offer (to realize the additional financial return), thereby accepting a greater risk of a bargaining breakdown and costly trial. The financial market would anticipate this and so the price at which the stock trades would reflect the inefficiencies of future litigation. The plaintiff will need to craft a financial strategy carefully to extract value from the defendant in a cost effective way.

For ease of notation, define $m(\pi) \equiv E(q \mid q \leq \pi) = \int_0^\pi q \frac{f(q)}{F(\pi)} dq$. In words, $m(\pi)$ is the expected mean probability that the plaintiff will win the case given that the distribution $f(\pi)$ is truncated above at π. As is standard in the literature, we also assume that the hazard rate is monotone: $\frac{\partial}{\partial \pi}\left(\frac{f(\pi)}{1-F(\pi)}\right) > 0$.[32] As in Nalebuff (1987), we assume that $m(1)D - c_p \geq 0$, so with a neutral position, the plaintiff is weakly better off taking all defendant types to trial rather than dropping the case.[33] Thus, the lawsuit has (at least weakly) positive expected value from the ex ante perspective.

4.1. Benchmark: Full Commitment

To begin, we extend Bebchuk (1984) to include financial investing by the plaintiff. In this benchmark, the plaintiff is committed to never drop the case and takes any defendant who rejects the settlement offer to trial. We show that by taking a shorter (longer) position, the plaintiff becomes more (less) aggressive in the settlement demand, and that the optimal financial position at $t = 0$ is a neutral one ($\Delta = 0$).

Suppose that the plaintiff established a financial stake Δ at price $v_0(\Delta)$ at $t = 0$. The plaintiff's problem at $t = 1$ is to choose a threshold $\hat{\pi}$ and a corresponding settlement offer $\hat{s} = \hat{\pi}D + c_d$ where defendant types below the threshold ($\pi < \hat{\pi}$) reject the settlement offer

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[32] This is true of many standard distributions, including uniform, normal, and exponential distributions.
[33] This assumption implies that there will be trials and/or settlements in equilibrium.

and defendant types above this threshold ($\pi \geq \hat{\pi}$) accept the offer.[34] Given Δ, the plaintiff's interim expected payoff is:

$$W^p(\hat{\pi}, \Delta) \equiv \int_0^{\hat{\pi}} [\pi D - c_p + (R - \pi D - c_d)\Delta] f(\pi) d\pi$$

$$+ \int_{\hat{\pi}}^1 [\hat{\pi} D + c_d + (R - \hat{\pi} D - c_d)\Delta] f(\pi) d\pi - v_0(\Delta)\Delta \tag{11}$$

The first part of this expression is the plaintiff's expected payoff from those defendant types $\pi \in [0, \hat{\pi})$ who reject the settlement offer and go to trial. For these types, the final market value v_3 will be either $R - D - c_d$ or $R - c_d$, depending on whether the plaintiff wins or loses at trial. Conditional on the defendant's type π, the expected market value if the case goes to trial is $R - \pi D - c_d$. The second part is the plaintiff's payoff from those defendant types who accept the settlement offer $\hat{s} = \hat{\pi} D + c_d$. For types $\pi \in [\hat{\pi}, 1]$, the expected market value is $R - \hat{\pi} D - c_d$.

At $t = 1$, the plaintiff chooses $\hat{\pi} \in [0, 1]$ to maximize $W^p(\hat{\pi}, \Delta)$. Taking the derivative of the interim payoff function with respect to $\hat{\pi}$, the slope is given by:

$$\frac{\partial W^p(\hat{\pi}, \Delta)}{\partial \hat{\pi}} \equiv -(c_p + c_d)f(\hat{\pi}) + (1 - \Delta)D[1 - F(\hat{\pi})] \tag{12}$$

This expression may be understood intuitively. When the plaintiff raises the threshold $\hat{\pi}$ and corresponding settlement offer $\hat{s}$ slightly, fewer defendant types will accept the settlement offer. The first term represents the additional litigation costs associated with the additional cases that go to court. The second term represents the benefit to the plaintiff of raising the threshold, since the infra marginal defendant types below the threshold $\hat{\pi}$ will accept the higher settlement offer. The plaintiff benefits directly through the higher settlement received and, when $\Delta < 0$, the plaintiff benefits indirectly because the stock value is lower in light of the higher settlement amount.

The optimal threshold may be an interior solution, $\hat{\pi}(\Delta) \in (0, 1)$, or a corner solution, $\hat{\pi}(\Delta) = 0$.[35] An interior solution, if one exists, is where the slope $\partial W^p(\hat{\pi}, \Delta)/\partial \hat{\pi}$ equals zero. Setting (6) equal to zero and rearranging, we get:

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[34] Without loss of generality, we assume that when indifferent, the defendant accepts the plaintiff's settlement offer instead of rejecting it. When the plaintiff offers to settle at $\hat{s} = \hat{\pi} D + c_d$, it is optimal for defendant type $\pi < \hat{\pi}$ to reject the offer and proceed to trial (expecting to lose $\pi D + c_d$ which is strictly smaller than $\hat{s}$) while it is (at least weakly) optimal for defendant type $\pi \geq \hat{\pi}$ to accept the offer.

$$\frac{(1-\Delta)D}{c_p + c_d} = \frac{f(\hat{\pi}(\Delta))}{1 - F(\hat{\pi}(\Delta))} \tag{13}$$

The monotone hazard rate assumption implies that the right-hand side is strictly increasing in $\hat{\pi}(\Delta)$, so an interior solution (if one exists) is unique. Furthermore, the monotone hazard rate implies that $\hat{\pi}'(\Delta) < 0$. When Δ falls (so the position becomes shorter) the left hand side rises and so $\hat{\pi}(\Delta)$, and the settlement offer $\hat{s}(\Delta)$, must rise as well. At the same time, when Δ is sufficiently positive, we can get $\partial W^p(\hat{\pi}, \Delta)/\partial\hat{\pi} < 0$ for all $\hat{\pi} \in [0,1]$. In that case, we get the corner solution of $\hat{\pi}(\Delta) = 0$. To allow for both possibilities, we let $\Delta_0 \in (-\infty, 1)$ to be the value where

$$\frac{(1-\Delta_0)D}{c_p + c_d} = f(0) \tag{14}$$

We now state the following result. A full proof is given in the appendix.

Lemma 2. *Suppose the plaintiff takes financial position Δ at $t = 0$, can make a take-it-or-leave-it offer to the privately informed defendant, and is committed to never drop the case. Then there exists a unique threshold $\hat{\pi}(\Delta)$ that maximizes the plaintiff's interim expected payoff. If $\Delta \geq \Delta_0$, then $\hat{\pi}(\Delta) = 0$. If $\Delta < \Delta_0$, then $\hat{\pi}(\Delta) > 0$, $\hat{\pi}'(\Delta) < 0$, and $\lim_{\Delta \to -\infty} \hat{\pi}(\Delta) = 1$. The case settles out of court if and only if $\pi \geq \hat{\pi}(\Delta)$.*

We will now show that, with commitment, the plaintiff can do no better than choose the neutral financial position of $\Delta = 0$ at $t = 0$. Since the capital market is assumed to be fully rational and forward looking, the capital market will anticipate the threshold $\hat{\pi}(\Delta)$ described in Lemma 2 and so the stock value at $t = 0$ is

$$v_0(\Delta) = \int_0^{\hat{\pi}(\Delta)} (R - \pi D - c_d)f(\pi)d\pi + \int_{\hat{\pi}(\Delta)}^1 (R - \hat{\pi}(\Delta)D - c_d)f(\pi)d\pi \tag{15}$$

Substituting this expression into the interim payoff function in (11) above, the plaintiff's ex ante expected payoff takes the following form:

$$W^p(\hat{\pi}(\Delta), \Delta) \equiv \int_0^{\hat{\pi}(\Delta)} [\pi D - c_p]f(\pi)d\pi + \int_{\hat{\pi}(\Delta)}^1 [\hat{\pi}(\Delta)D + c_d]f(\pi)d\pi \tag{16}$$

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[35] It is never optimal for the plaintiff to choose $\hat{\pi} = 1$ and litigate with all defendant types, since, with $\hat{\pi} = 1$, we get $-(c_p + c_d)f(1) + (1-\Delta)D[1 - F(1)] < 0$. In short, $\hat{\pi}(\Delta) \in [0,1)$ and whenever $\hat{\pi}(\Delta) > 0$, $\hat{\pi}'(\Delta) < 0$.

This expression is strikingly simple. The plaintiff's ex ante payoff doesn't depend on the financial position directly, so $W^p(\hat{\pi}(\Delta), \Delta) \equiv W^p(\hat{\pi}(\Delta), 0)$. That is because, in equilibrium, the plaintiff breaks even on its financial investment. The plaintiff's payoff does depend on Δ indirectly, insofar as the financial position affects the threshold $\hat{\pi}(\Delta)$. The threshold that maximizes the plaintiff's ex ante payoff, $W^p(\hat{\pi}(\Delta), 0)$, is $\hat{\pi}(0)$ and so the optimal financial position for the plaintiff is $\Delta = 0$.

Proposition 3. *Suppose the plaintiff makes a take-it-or-leave-it offer to a privately informed defendant and is committed to never drop the case. The plaintiff's ex ante payoff is maximized with a neutral financial position, $\Delta = 0$. The plaintiff offers $\hat{s}(0) = \hat{\pi}(0)D + c_d$. If $\pi \geq \hat{\pi}(0)$, the defendant accepts the offer; and if $\pi > \hat{\pi}(0)$, the defendant rejects the offer and the case goes to trial.*

In the commitment benchmark, the plaintiff would never want to "dump and sue." Suppose that $\Delta = 0 < \Delta_0$. According to Lemma 2, an interior solution is obtained when the plaintiff takes a neutral position: $\hat{\pi}(0) \in (0,1)$. Since $\hat{\pi}'(\Delta) < 0$, taking a slightly long position with $\Delta > 0$ will make the plaintiff less aggressive at the interim stage, and the plaintiff will reduce settlement offer and the threshold, $\hat{\pi}(\Delta) < \hat{\pi}(0)$. This reduces the plaintiff's ex ante payoff in (10). If the plaintiff takes a slightly short position with $\Delta < 0$ then the plaintiff will be more aggressive at the interim stage, and will increase the settlement offer and corresponding threshold, $\hat{\pi}(\Delta) > \hat{\pi}(0)$. Again, this reduces the plaintiff's ex ante payoff. Taking a financial position different from $\Delta = 0$ only distorts the plaintiff's interim incentives and reduces the plaintiff's ex ante expected payoff.[36]

4.2 Settlement without Commitment

The commitment benchmark in the previous subsection deliberately sidestepped the issue of credibility. Suppose that the plaintiff takes a neutral financial position, $\Delta = 0$. As argued by Nalebuff (1987), the plaintiff may not have a credible threat to take the defendant to trial following the rejection of the full commitment settlement offer, $\hat{s}(0)$. If the settlement offer $\hat{s}(0)$ is too low, then the plaintiff would prefer to drop the case rather than litigate against defendant types on the truncated support $[0, \hat{\pi}(0)]$ and once the defendant knows that the plaintiff will drop the case, the defendant will not accept the full commitment settlement offer. In order to maintain a credible threat to go to trial, the plaintiff would raise the settlement offer to a higher value, which we call $\bar{s}(0) > \hat{s}(0)$. In this situation, we will see

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[36] If $\Delta = 0 > \Delta_0$, then any $\Delta \geq \Delta_0$ will lead to $\hat{\pi}(\Delta) = \hat{\pi}(0) = 0$. Also, setting $\Delta < \Delta_0$ will only make the plaintiff ex ante worse off. Setting $\Delta = 0$ is, therefore, weakly optimal.

that taking a short position with $\Delta < 0$ will be valuable for the plaintiff. It will allow the plaintiff to relax the credibility constraint and make a lower settlement offer $s^*(\Delta)$ where $\hat{s}(0) < s^*(\Delta) < \bar{s}(0)$. Interestingly, this lower settlement offer benefits not only the plaintiff but also the defendant.

Let us start by defining a key piece of new notation. Let $\bar{\pi}(\Delta) \in [0,1]$ to be such that if the distribution of defendant types $f(\pi)$ were restricted to the range $[0, \bar{\pi}(\Delta)]$, then the plaintiff would be indifferent between dropping the case and going to trial. Specifically, define $\bar{\pi}(\Delta)$ to be the implicit solution to

$$m(\bar{\pi}(\Delta))D + c_d - \left(\frac{c_p + c_d}{1 - \Delta}\right) = 0 \qquad (17)$$

This threshold does not always exist. When $\Delta < -\frac{c_p}{c_d}$, then the left hand side is positive even if $\bar{\pi}(\Delta) = 0$ so the plaintiff has a credible threat to go to trial regardless of its belief. If $\Delta > \frac{m(1)D - c_p}{m(1)D + c_d} \geq 0$, the left hand side is negative even if $\bar{\pi}(\Delta) = 1$, so the plaintiff would strictly prefer to drop the case even when facing the entire distribution of defendant types. Thus, the function $\bar{\pi}(\Delta)$ is only defined when:

$$\Delta \in \Omega \equiv \left[-\frac{c_p}{c_d}, \frac{m(1)D - c_p}{m(1)D + c_d}\right] \qquad (18)$$

In other words, Ω is the set of values of Δ for which the threshold $\bar{\pi}(\Delta)$ exists.

Lemma 3. *When $\Delta \in \Omega$ then $\bar{\pi}(\Delta) \in [0,1]$ exists, is unique, and has the following properties:* $\bar{\pi}\left(-\frac{c_p}{c_d}\right) = 0, \bar{\pi}\left(\frac{m(1)D - c_p}{m(1)D + c_d}\right) = 1,$ *and* $\bar{\pi}'(\Delta) > 0.$

The threshold $\bar{\pi}(\Delta)$, and the corresponding threshold settlement offer $\bar{s}(\Delta) = \bar{\pi}(\Delta)D + c_d$, are critical for the plaintiff's settlement strategy. Suppose the optimal offer with full commitment is $\hat{s}(\Delta) > \bar{s}(\Delta)$. In the continuation equilibrium, defendants with types $\pi \geq \hat{\pi}(\Delta) > \bar{\pi}(\Delta)$ accept the offer, and those with types $\pi < \hat{\pi}(\Delta)$ reject the offer and are taken to court. The plaintiff's threat to go to trial is credible in this case. If $\hat{s}(\Delta) < \bar{s}(\Delta)$, however, then it is no longer a continuation equilibrium for the defendant to accept the offer if and only if $\pi \geq \hat{\pi}(\Delta)$. If that were true, then the plaintiff would strictly prefer to drop the case and not take the remaining defendant types to trial.

The next proposition, which is proven in the appendix, characterizes the equilibrium of the continuation game conditional on Δ. Specifically, there is a unique value $\Delta^* \in \Omega$ that

satisfies $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*)$. When $\Delta \leq \Delta^*$ then $\hat{\pi}(\Delta) \geq \bar{\pi}(\Delta)$ and the credibility constraint does not bind and the plaintiff offers $s^*(\Delta) = \hat{\pi}(\Delta)D + c_d$ as in the benchmark case with full commitment. When $\Delta > \Delta^*$ then $\hat{\pi}(\Delta) < \bar{\pi}(\Delta)$ and the credibility constraint does bind. In this case, the plaintiff offers to settle for $s^*(\Delta) = \bar{\pi}(\Delta)D + c_d$ or, if the financial stake Δ is sufficiently large, the plaintiff will simply drop the case.

Proposition 4. *Suppose the plaintiff has taken a financial position Δ at $t = 0$ and can make a take-it-or-leave-it offer to the privately informed defendant. There exists a $\Delta^* \in \Omega$ such that $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*)$. For $\Delta \in \Omega$, if $\Delta \leq \Delta^*$, then $\hat{\pi}(\Delta) \geq \bar{\pi}(\Delta)$ and if $\Delta > \Delta^*$, then $\hat{\pi}(\Delta) < \bar{\pi}(\Delta)$.*

1. *If $\Delta \leq \Delta^*$, the plaintiff offers to settle for $s^*(\Delta) = \hat{\pi}(\Delta)D + c_d$. The defendant accepts if and only if $\pi \geq \hat{\pi}(\Delta)$. If the offer is rejected, the case goes to trial.*

2. *If $\Delta \in \left(\Delta^*, \frac{m(1)D - c_p}{m(1)D + c_d}\right]$, the plaintiff offers to settle for $s^*(\Delta) = \bar{\pi}(\Delta)D + c_d$. The defendant accepts if and only if $\pi \geq \bar{\pi}(\Delta)$. If the offer is rejected, the case goes to trial.*

3. *If $\Delta > \frac{m(1)D - c_p}{m(1)D + c_d}$, the defendant rejects any positive offer and the plaintiff drops the case.*

4.3 The Plaintiff's Choice of Financial Position

We now characterize the plaintiff's choice of financial position at $t = 0$. The firm's market valuation, $v_0(\Delta)$, will reflect the rational expectations of the capital market and will be consistent with the continuation equilibrium outlined in Proposition 4. Specifically, if the capital market observes Δ in cases 1 or 2 of the proposition, the market believes that the plaintiff will offer to settle for $s^*(\Delta) = \pi^*(\Delta)D + c_d$ and that the defendant will accept if and only if $\pi \geq \pi^*(\Delta)$.[37] Conditional on the defendant's type being $\pi < \pi^*(\Delta)$, the expected future market value of the firm is $R - \pi D - c_d$. Conditional on the defendant's type being $\pi \geq \pi^*(\Delta)$, the expected future value of the firm is $R - s^*(\Delta) = R - \pi^*(\Delta)D - c_d$. Therefore, when evaluated at time $t = 0$, the expected market value of the firm is

$$v_0(\Delta) = \int_0^{\pi^*(\Delta)} (R - \pi D - c_d)f(\pi)d\pi + \int_{\pi^*(\Delta)}^1 (R - \pi^*(\Delta)D - c_d)f(\pi)d\pi \qquad (19)$$

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[37] The plaintiff would never choose to be in case 3 of Proposition 4. In case 3, the plaintiff would earn nothing from either the financial investment or the litigation. Since $m(1)D - c_p > 0$ by our earlier assumption, the plaintiff would be better off with $\Delta = 0$ and taking all defendant types to court. Therefore $\Delta > \frac{m(1)D - c_p}{m(1)D + c_d}$ is a strictly dominated strategy for the plaintiff.

As before, the plaintiff cannot make an equilibrium return from the financial investment. The plaintiff's ex ante expected payoff depends on financial position Δ only through its indirect effect on the settlement offer and corresponding threshold, $\pi^*(\Delta)$:

$$W^p(\pi^*(\Delta), \Delta) = \int_0^{\pi^*(\Delta)} [\pi D - c_p] f(\pi) d\pi + \int_{\pi^*(\Delta)}^1 [\pi^*(\Delta) D + c_d] f(\pi) d\pi \qquad (20)$$

This expression is familiar from the commitment benchmark in the last section. If the plaintiff could commit to a threshold at $t = 0$, they would choose $\pi^*(\Delta) = \hat{\pi}(0)$. The threshold and corresponding settlement offer would be exactly the same as in our benchmark case with full commitment. In the current setting, however, the plaintiff cannot commit not to drop the case. When $\Delta^* < 0$, if the plaintiff took a neutral financial position with $\Delta = 0$ then according to Proposition 4 we would have $\hat{\pi}(0) < \bar{\pi}(0)$. The plaintiff cannot successfully implement $\hat{\pi}(0)$, since the threat to litigate following rejection of offer $\hat{s}(0) = \hat{\pi}(0)D + c_d$ not credible. As in Nalebuff (1987), the plaintiff would need to raise the offer up to $\bar{s}(0) = \bar{\pi}(0)D + c_d$.

When $\Delta^* < 0$, shorting the defendant's stock benefits the plaintiff by relaxing the credibility constraint. The plaintiff will not take an arbitrarily short position however. In equilibrium, the plaintiff will take on a short position that is just large enough so that the credibility constraint is satisfied but not strictly binding. That is, the plaintiff chooses position Δ^* where $\bar{\pi}(\Delta^*) = \hat{\pi}(\Delta^*)$ and subsequently make an offer $s^*(\Delta^*) = \hat{\pi}(\Delta^*)D + c_d$. Since $\hat{\pi}(0) < \hat{\pi}(\Delta^*) < \bar{\pi}(0)$, the plaintiff has achieved a settlement threshold $\hat{\pi}(\Delta^*)$ that is closer to the commitment threshold $\bar{\pi}(0)$.

Proposition 5. *Suppose the plaintiff makes a take-it-or-leave-it offer to a privately informed defendant. When $\Delta^* \geq 0$, the plaintiff's ex ante expected return is maximized by not investing in the defendant's stock $(\Delta = 0)$. When $\Delta^* < 0$, the plaintiff's ex ante expected return is maximized by taking the short position $\Delta^* < 0$ such that $\hat{\pi}(0) < \bar{\pi}(\Delta^*) = \hat{\pi}(\Delta^*) < \bar{\pi}(0)$. The probability of litigation is lower and the plaintiff and defendant are better off when the plaintiff can short the defendant's stock.*

It is worth re-emphasizing that, when $\Delta^* < 0$, the plaintiff and the defendant are strictly better off in expectation when the plaintiff can short the stock of the defendant. With $\Delta^* < 0$, shorting the stock allows the plaintiff to relax its own incentive compatibility constraint, which leads to a lower settlement offer than would be obtained otherwise: $s^*(\Delta^*) < \bar{s}(0)$. The defendants with types $\pi \in [\bar{\pi}(0), 1]$ benefit from this, since they pay less in settlement when $\Delta = \Delta^*$ than they would if $\Delta = 0$. The defendants with types $\pi \in$

$(\overline{\pi}(\Delta^*), \overline{\pi}(0))$ benefit as well, since these types settle when $\Delta = \Delta^*$ but would have gone to trial if $\Delta = 0$. Note also that the litigation rate is lower as a consequence of short selling, and so the expected litigation costs are lower as well. So, in this admittedly limited sense, social welfare rises when the plaintiff shorts the defendant's stock.

Numerical Example. Suppose that π is distributed uniformly on the unit interval, so that $f(\pi) = 1$ and $F(\pi) = \pi$, and $D = 100$ and $c_p = c_d = 30$. The set $\Omega \equiv [-1, 1/4]$. The two threshold functions are:

$$\hat{\pi}(\Delta) = \frac{0.4 - \Delta}{1 - \Delta} \quad \text{and} \quad \overline{\pi}(\Delta) = \frac{0.6(1 + \Delta)}{1 - \Delta} \tag{21}$$

as shown in Figure 1 below. When $\Delta = 0$, then $\hat{\pi}(0) = 2/5$ and $\overline{\pi}(0) = 3/5$. If the plaintiff could commit, the plaintiff would choose the settlement offer $\hat{s}(0) = \hat{\pi}(0)D + c_d = 40 + 30 = 70$ and defendants with types below $\hat{\pi}(0) = 2/5$ would reject and go to trial. The plaintiff's expected payoff is 38 and the defendant's expected payments are 62 in this case.[38] However, since $m(0.4)D - c_p = 20 - 30 = -10$, the plaintiff's threat to go to trial is not credible. The plaintiff would therefore raise the offer to $\overline{s}(0) = \overline{\pi}(0)D + c_d = 60 + 30 = 90$. The plaintiff now has a credible threat to go to trial following rejection since $m(0.6)D - c_p = 30 - 30 = 0$. The plaintiff's expected payoff is $36 < 38$ and the defendant's expected payment is $72 > 62$. With the credibility constraint binding, the plaintiff can improve her return by taking a short position. The plaintiff's optimal short position is $\Delta^* = -1/8$, the value where $\hat{\pi}(\Delta^*) = \overline{\pi}(\Delta^*) = 7/15$. With $\Delta^* = -1/8$, the plaintiff offers $s^*(\Delta^*) = \hat{\pi}(\Delta^*)D + c_d \approx 47 + 30 = 77$, the plaintiff's ex ante expected profit is $W^p(\hat{\pi}(\Delta^*), \Delta^*) = 37.8$, and the defendant's expected payment is approximately 66. In this case, with the short position, both the plaintiff and the defendant are better off.

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[38] If the plaintiff chooses $\hat{\pi}(0) = 0.4$, the plaintiff's expected payoff is $F(0.4)(m(0.4)D - c_p) + (1 - F(0.4))(0.4D + c_d) = 38$ and the defendant's expected payment is $F(0.4)(m(0.4)D + c_d) + (1 - F(0.4))(0.4D + c_d) = 62$. If the plaintiff chooses $\overline{\pi}(0) = 0.6$, the plaintiff's expected payoff is $F(0.6)(m(0.6)D - c_p) + (1 - F(0.6))(0.6D + c_d) = 36$ and the defendant's expected payment is $F(0.6)(m(0.6)D + c_d) + (1 - F(0.6))(0.6D + c_d) = 72$.
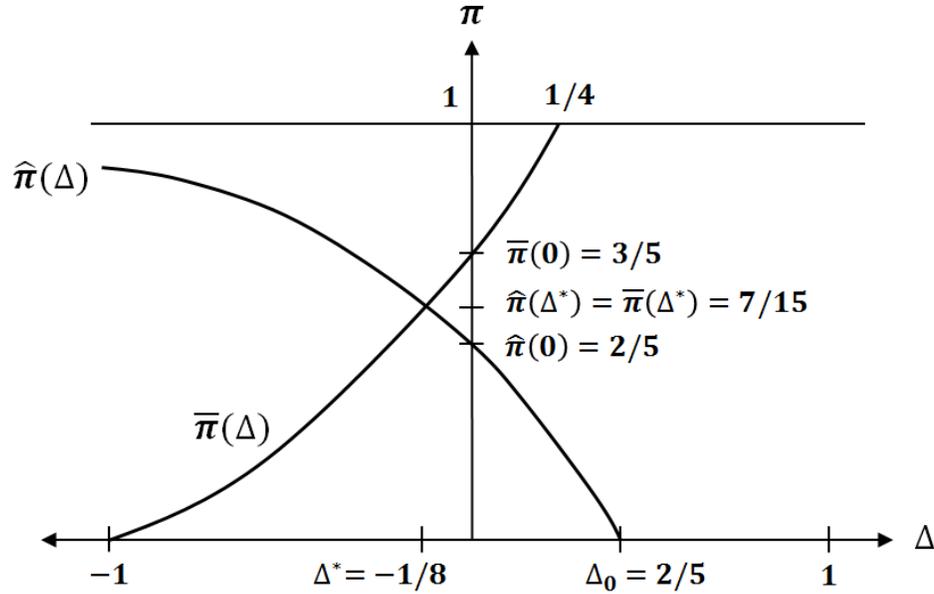
Figure 1: $\pi \sim U[0, 1], D = 100, c_p = c_d = 30$

The figure shows curves $\hat{\pi}(\Delta)$ and $\overline{\pi}(\Delta)$ with axes π (vertical) and Δ (horizontal). Marked values: 1, $1/4$, $\overline{\pi}(0) = 3/5$, $\hat{\pi}(\Delta^*) = \overline{\pi}(\Delta^*) = 7/15$, $\hat{\pi}(0) = 2/5$, -1, $\Delta^* = -1/8$, $\Delta_0 = 2/5$, 1.

More generally, however, short selling by the plaintiff could make the defendant worse off and could raise rather than lower the likelihood of litigation. When the plaintiff and defendant were symmetrically informed about the stakes of the case, we clearly saw the former effect. Through short selling, the plaintiff made litigation credible and shifted the bargaining outcome in its own favor. In the current section with asymmetric information, if we had made the alternative assumption that $m(1)D - c_p < 0$, then there would be no settlement or litigation when $\Delta = 0$. Recall however that by taking a sufficiently short position, $\Delta \le -\frac{c_p}{c_d}$, the plaintiff could make it credible to litigate against all defendant types, even against the defendant type of $\pi = 0$. More generally, when choosing its financial position, the plaintiff would trade off the desire to achieve credibility and extract a settlement from the defendant and the distortion of their own interim incentive to raise the settlement offer. When $m(1)D - c_p < 0$, the plaintiff may choose to run the risk of a costly trial and, in this case, the likelihood of litigation could rise.

5. Asymmetric Information: Signaling

In this section, we adopt a bargaining protocol where the informed defendant makes a single take-it-or-leave-it offer to the uninformed plaintiff. The model closely follows the

signaling model of Reinganum and Wilde (1986).[39] We characterize the fully-separating perfect Bayesian equilibrium where the offer fully reveals the defendant's type and makes the plaintiff indifferent between accepting the offer and rejecting the offer and going to trial. The plaintiff subsequently randomizes between accepting the offer and going to trial.[40] As in Reinganum and Wilde (1986), we assume that all cases have positive expected value (absent short selling by the defendant). Specifically, we assume that $f(\pi)$ is distributed on support $[\underline{\pi}, 1]$ where $\underline{\pi} D - c_p > 0$. Although short selling is not necessary for credibility, it is valuable because it will improve the terms of settlement offered by the defendant.

Before analyzing the model with asymmetric information, let us briefly revisit the case of *symmetric information* where the defendant can make a take-it-or-leave-it offer to the plaintiff ($\theta = 1$). Since $\pi D - c_p > 0$ for all $\pi \in [\underline{\pi}, 1]$, the plaintiff has a credible threat to litigate absent short selling. If $\Delta = 0$, then the defendant would offer $s(0) = \pi D - c_p$ and the plaintiff would accept. With short selling, the defendant would need to raise the settlement offer to get the plaintiff to accept. As in Proposition 1, in the limit as $\Delta \to -\infty$, the defendant's settlement offer would converge to $\pi D + c_d$. So with symmetric information about π, the plaintiff would want to take an arbitrarily short position.

With *asymmetric information*, the same basic force is at play. By taking a short position in the defendant's stock, the plaintiff can induce the defendant to make a more generous settlement offer. At the same time, short selling will distort the plaintiff's interim incentives, making it more likely that the plaintiff will reject the defendant's (more generous) settlement offers, and therefore more litigation will occur in equilibrium. This creates a tradeoff for the plaintiff. The plaintiff chooses the financial position ex ante to optimally balance these effects.

5.1 The Bargaining Outcome

Let the settlement offer made by the defendant of type π to a plaintiff with financial position Δ be denoted by $\sigma(\pi; \Delta)$. In a fully-separating equilibrium, the plaintiff infers the defendant's type from the offer and is indifferent between accepting the offer and going to trial. Thus, the settlement offer must be exactly the same as the lower bound of the settlement range characterized earlier:

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[39] In Reinganum and Wilde (1986), the plaintiff was privately informed and made an offer to the uninformed defendant.

[40] Pooling equilibria are eliminated with the D1 refinement of Cho and Kreps (1987).

$$\sigma(\pi; \Delta) \equiv \underline{s}(\Delta) = \pi D + c_d - \left(\frac{c_p + c_d}{1 - \Delta}\right) \tag{22}$$

Note that this settlement offer is increasing in π, so higher offers correspond to higher defendant types. It is also decreasing in Δ, so shorter financial positions induce higher offers. Our earlier assumption that $\underline{\pi}D - c_p > 0$ guarantees that the settlement offer $\sigma(\pi; \Delta)$ is strictly positive when $\Delta \leq 0$. In the limit as $\Delta \to -\infty$, the the entire schedule of offers converges to $\pi D + c_d$.

Let $p(\pi; \Delta)$ denote the equilibrium probability that the plaintiff accepts the offer $\sigma(\pi; \Delta)$. We will construct a closed form solution for this probability. Suppose the defendant is of type π and makes a settlement offer corresponding to type $\tilde{\pi}$ in the fully-separating equilibrium. After receiving an offer to settle for $\sigma(\tilde{\pi}; \Delta)$, the plaintiff believes that the defendant is type $\tilde{\pi}$ and mixes with probability $p(\tilde{\pi}; \Delta)$, giving the type π defendant an expected payment of

$$p(\tilde{\pi}; \Delta) \left[\tilde{\pi} D + c_d - \left(\frac{c_p + c_d}{1 - \Delta}\right)\right] + (1 - p(\tilde{\pi}; \Delta))[\pi D + c_d] \tag{23}$$

The first term represents the payments made by the defendant if the settlement offer is accepted; the second term represents the payments made if the case goes to trial.

Incentive compatibility requires that a defendant of type π would not want to misrepresent himself and pretend to be type $\tilde{\pi} \neq \pi$. Taking the derivative of (23) with respect to $\tilde{\pi}$ and setting the slope equal to zero when $\tilde{\pi} = \pi$ gives:

$$p(\pi; \Delta)D - \frac{\partial p(\pi; \Delta)}{\partial \Delta}\left(\frac{c_p + c_d}{1 - \Delta}\right) = 0 \tag{24}$$

This is a first-order differential equation with general solution $p(\pi; \Delta) = \beta e^{\frac{\pi(1-\Delta)D}{c_p + c_d}}$ where β is an arbitrary constant. When $\beta > 0$ this function is increasing in π, so higher defendant types are more likely to accept. It must be the case that $p(1; \Delta) = 1$, so the defendant with the highest type has his offer accepted for sure. If this were not true, so $p(1; \Delta) < 1$, then the defendant could raise his offer slightly and the plaintiff would accept regardless of the beliefs held about the defendant's true type. Using this boundary condition, $p(1; \Delta) = 1$, we establish the value for the constant $\beta = e^{\frac{-(1-\Delta)D}{c_p + c_d}}$ and we have the following result.

Proposition 6. *Suppose the informed defendant makes a take-it-or-leave-it offer to the uninformed plaintiff who has taken financial position Δ at time $t = 0$. In the fully-separating perfect Bayesian equilibrium, the defendant offers:*

$$\sigma(\pi; \Delta) \equiv \underline{s}(\Delta) = \pi D + c_d - \left(\frac{c_p + c_d}{1 - \Delta}\right)$$

where $\frac{\partial \sigma(\pi; \Delta)}{\partial \Delta} < 0$ and $\lim_{\Delta \to -\infty} \sigma(\pi; \Delta) = \pi D + c_d$. The plaintiff accepts with probability

$$p(\pi; \Delta) = e^{\frac{-(1-\pi)(1-\Delta)D}{c_p + c_d}} \tag{25}$$

and goes to trial otherwise. $p(\pi; \Delta) > 0$, $p(1; \Delta) = 1$, $\frac{\partial p(\pi; \Delta)}{\partial \pi} > 0$, $\frac{\partial p(\pi; \Delta)}{\partial \Delta} > 0$, and $\lim_{\Delta \to -\infty} p(\pi; \Delta) = 0$ $\forall \pi \in [0,1)$.

Several observations are in order. First, the defendant's settlement offer $\sigma(\pi; \Delta)$ and the plaintiff's probability of acceptance $p(\pi; \Delta)$ are both increasing in the defendant's type π. To maintain an incentive for the defendant to truthfully reveal his type, the plaintiff must be more likely to accept higher settlement offers than lower ones. Second, the settlement offer $\sigma(\pi; \Delta)$ is decreasing and the probability of acceptance is increasing in the plaintiff's financial position Δ. Thus, when Δ becomes smaller, so the plaintiff's position is shorter, then the settlement offer becomes higher and the plaintiff is more likely to reject the settlement offer and go to trial. Short selling by the plaintiff will increase the equilibrium rate of litigation.

5.2 The Plaintiff's Choice of Financial Position

Now that we have characterized the continuation equilibrium given Δ, we can explore the plaintiff's optimal choice of Δ at time $t = 0$. To do this, we must construct the plaintiff's ex ante expected payoff from the game. Following the logic in the previous sections, the capital market fully anticipates the continuation game that follows the plaintiff's choice of financial position, Δ. Therefore the ex ante market value $v_0(\Delta)$ is equal to the expected future market value of the firm. As a consequence, the plaintiff cannot earn any direct return from its financial investing activities—the plaintiff will just break even on the short selling of the defendant's stock. The plaintiff may benefit from the short position indirectly, however, through its impact on the bargaining outcome.

Since the plaintiff's ex ante return from the financial investment is zero, the plaintiff's expected ex ante payoff is simply:

$$\int_{\underline{\pi}}^{1} p(\pi; \Delta)\sigma(\pi; \Delta)f(\pi)d\pi \ + \ \int_{\underline{\pi}}^{1} (1 - p(\pi; \Delta))(\pi D - c_p)f(\pi)d\pi \tag{26}$$

The first part of this expression represents settlement payments from the defendant, since the plaintiff accepts settlement offer $\sigma(\pi; \Delta)$ with probability $p(\pi; \Delta)$. The second part of this expression represents the expected damages minus litigation costs since, with probability $1 - p(\pi; \Delta)$, the plaintiff rejects the defendant's settlement offer and goes to trial. Using the expressions for $\sigma(\pi; \Delta)$ and $p(\pi; \Delta)$ in equations (22) and (25) above, we can write the plaintiff's ex ante payoff as:

$$V^p(\Delta) = \int_{\underline{\pi}}^{1} (\pi D - c_p)f(\pi)d\pi \ - \ \left(\frac{\Delta}{1-\Delta}\right)(c_p + c_d)\int_{\underline{\pi}}^{1} e^{\frac{-(1-\pi)(1-\Delta)D}{c_p+c_d}} f(\pi)d\pi \tag{27}$$

Suppose that $\Delta = 0$ so the plaintiff takes no financial position. In this case the second term is zero. The defendant will offer to settle for $\sigma(\pi; 0) = \pi D - c_p$, making the plaintiff indifferent between settlement and trial. Therefore the plaintiff's payoff is exactly what it would be if the plaintiff went to trial against all defendant types. Suppose instead that the plaintiff takes a long position in the defendant's stock, $\Delta > 0$. In this case, the second term in expression (27) is negative. Knowing that the plaintiff is in a weak bargaining position, the defendant would offer to settle for $\sigma(\pi; \Delta) < \pi D - c_p$ and the plaintiff is worse off ex ante.

It is clear from the expression for $V^p(\Delta)$ in (27) that the plaintiff is strictly better off if he shorts the defendant's stock at time $t = 0$. When $\Delta < 0$, the second term is strictly positive and so the plaintiff will be strictly better off ex ante. By taking a short position, the plaintiff induces the defendant to make a settlement offer $\sigma(\pi; \Delta) > \pi D - c_p$. The plaintiff captures the benefit of this higher settlement offer only insofar as the offer is subsequently accepted. If the plaintiff rejects the settlement offer and the case goes to trial, the plaintiff is no worse off than he would be in the setting where $\Delta = 0$ and $\sigma(\pi; 0) = \pi D - c_p$.

Proposition 7. *Suppose the informed defendant makes a take-it-or-leave-it offer to the uninformed plaintiff. The plaintiff's ex ante expected return is maximized by taking short position $\Delta^{**} < 0$ that maximizes $V^p(\Delta)$ in (27). The probability of litigation is higher, the plaintiff is better off, the defendant is worse off, and the litigation rate is higher when the plaintiff can short the defendant's stock ($\Delta^{**} < 0$) than when he cannot ($\Delta = 0$).*

Recall that in our earlier analysis with symmetric information, the plaintiff wanted to take the shortest possible financial position. This is not the case here, however. As Δ becomes smaller, the schedule of settlement offers $\sigma(\pi; \Delta)$ converges to $\pi D + c_d$. However,

to maintain incentive compatibility, the likelihood that the plaintiff accepts an offer $\sigma(\pi; \Delta)$ is falling. In the limit when Δ approaches negative infinity the probability $p(\pi; \Delta)$ approaches zero for all $\pi < 1$. (When $\pi = 1$, the probability of acceptance is equal to $p(1; \Delta) = 1$.) The upshot is that while taking a very short position on the defendant's stock has the advantage of raising the defendant's offer, the reduced probability of acceptance at the interim stage mitigates the plaintiff's gain from the ex ante perspective.

Conclusion

This paper has analyzed a model of litigation where the plaintiff has or can acquire a financial position in the defendant. This issue has become quite salient recently when a prominent hedge fund manager brought numerous patent challenges against pharmaceutical companies while shorting their stock. The analysis has shown that the plaintiff gains a strategic advantage by taking a short position in the defendant's stock even though, with fully rational and forward-looking financial market, the plaintiff makes no positive return from the financial position. Such strategic advantages are two-fold. First, when the lawsuit itself has a negative expected value, taking a short position against the defendant allows the plaintiff to turn the lawsuit into a positive expected value one. Second, the short position raises the minimum amount of settlement that the plaintiff is willing to accept, thereby improving the settlement return for the plaintiff. When the defendant is privately informed about the probability of winning at trial, the plaintiff balances the benefits of relaxing the credibility constraint against the costs of bargaining failure. When credibility is an issue, the paper has shown that short selling can actually benefit both the plaintiff and the defendant by making the plaintiff less aggressive in settlement demands and lowering the probability of going to a costly trial. By analyzing the plaintiff's financial strategy, the paper contributes to the existing literature on litigation, particularly those on negative expected value suits and gaining strategic advantage through third-party contracts.

Appendix: Proofs

Analysis of Endogenous Litigation Costs. This section presents a more detailed analysis of the Tullock contest. The plaintiff has a credible threat to go to trial for all $\Delta < 1$ by revealed preference. Given c_d^*, the plaintiff could would achieve the same payoff as dropping the case by spending $c_p = 0$. By spending more than zero, the plaintiff does strictly better. Given Δ, the most the firm is willing to pay in settlement is:

$$\bar{s}(\Delta) = \pi(c_p^*, c_d^*)D + c_d^* \leq D \tag{A1}$$

The defendant's reservation value is now a function of Δ since the equilibrium litigation expenditures, c_p^* and c_d^*, depend on Δ. The property that $\bar{s}(\Delta) \leq D$ follows from revealed preference. Since the defendant can guarantee itself an exposure of D by spending nothing at all, the most the defendant is willing to pay is capped at this level.

Consider the equilibrium characterization of the expenditures in the text. Multiplying the numerators and denominators of expressions for c_p^* and c_d^* by $(1 - \Delta)^{-2r}$, we can rewrite the expressions for the equilibrium litigation expenditures as:

$$c_p^* = \frac{(1-\Delta)^{1-r}}{\left[\frac{1}{(1-\Delta)^r}+1\right]^2} \, rD \qquad \text{and} \qquad c_d^* = \frac{(1-\Delta)^{-r}}{\left[\frac{1}{(1-\Delta)^r}+1\right]^2} \, rD$$

In the limit as Δ approaches negative infinity, the denominators of these two expressions converge to one. Since the exponent in the numerator of the first expression is positive, $1 - r > 0$, c_p^* grows without bound. Since the exponent in the second expression is negative, c_d^* approaches zero. Note however that c_d^* is not monotonic in Δ. Specifically, c_d^* is an increasing function of Δ when $\Delta < 0$ and an increasing function of Δ when $\Delta > 0$. When $\Delta = 1$ then $c_d^* = 0$. The plaintiff's litigation spending c_p^* rises without bound as Δ becomes more and more negative and the defendant's litigation spending c_d^* converges to zero.

We will now prove that $\bar{s}(\Delta)$ is a decreasing function using the envelope theorem. Since the defendant chooses its litigation expenditure c_d^* optimally given its belief about the plaintiff's choice c_p^*, we need only consider the effect of Δ on $\bar{s}(\Delta)$ through the plaintiff's equilibrium expenditure, c_p^*. Specifically, since $\pi(c_p^*, c_d^*)$ is an increasing function of c_p^*, an increase in Δ would lower $\pi(c_p^*, c_d^*)$ as well. Since $c_p^*(\Delta) = \frac{(1-\Delta)^{1+r}}{[1+(1-\Delta)^r]^2} \, rD$, we have

$$\frac{\partial c_p^*(\Delta)}{\partial \Delta} = \frac{-[1+(1-\Delta)^r]^2(1+r)(1-\Delta)^r + (1-\Delta)^{1+r}2[1+(1-\Delta)^r]r(1-\Delta)^{r-1}}{[1+(1-\Delta)^r]^4} \, rD$$

$$\frac{\partial c_p^*(\Delta)}{\partial \Delta} = \frac{[1+(1-\Delta)^r](1-\Delta)^r}{[1+(1-\Delta)^r]^4} \{-[1+(1-\Delta)^r](1+r) + 2r(1-\Delta)^r\}rD$$

$$\frac{\partial c_p^*(\Delta)}{\partial \Delta} = \frac{[1 + (1 - \Delta)^r](1 - \Delta)^r}{[1 + (1 - \Delta)^r]^4} \{-(1 + r) - (1 - r)(1 - \Delta)^r\} rD < 0 \tag{A2}$$

The fraction is positive and the second term in curly brackets is negative for all $\Delta < 1$ and $r \in (0,1)$. Thus, $c_p^*(\Delta)$ is a decreasing function of Δ. So, an increase in Δ reduces the most that the defendant is willing to pay in settlement.

Given Δ, the least that the that the plaintiff is willing to accept is

$$\underline{s}(\Delta) = \pi(c_p^*, c_d^*)D + c_d^* - \left(\frac{c_p^* + c_d^*}{1 - \Delta}\right)$$

Since $c_p^* = c_d^*(1 - \Delta)$, this becomes

$$\underline{s}(\Delta) = \pi(c_p^*, c_d^*)D - \left(\frac{c_d^*}{1 - \Delta}\right) \tag{A3}$$

We will now prove that $\underline{s}(\Delta)$ is a decreasing function of Δ. Our argument will proceed in two parts. First, we will show that $\pi(c_p^*, c_d^*)$ is decreasing in Δ. Then, we will show that $-c_d^*/(1 - \Delta)$ is also decreasing in Δ. Abusing notation slightly, let $\pi(\Delta) = \pi(c_p^*, c_d^*) = \frac{(1-\Delta)^r}{1+(1-\Delta)^r}$. Taking the derivative, we have

$$\frac{\partial \pi(\Delta)}{\partial \Delta} = \frac{-[1 + (1 - \Delta)^r]r(1 - \Delta)^{r-1} + (1 - \Delta)^r r(1 - \Delta)^{r-1}}{[1 + (1 - \Delta)^r]^2} = \frac{-r(1 - \Delta)^{r-1}}{[1 + (1 - \Delta)^r]^2} < 0$$

Next, let us define

$$\varphi(\Delta) \equiv \frac{-c_d^*(\Delta)}{1 - \Delta} = \frac{-(1 - \Delta)^{r-1}}{[1 + (1 - \Delta)^r]^2} rD \tag{A4}$$

Taking the derivative, we get:

$$\frac{\partial \varphi(\Delta)}{\partial \Delta} = \frac{[1 + (1 - \Delta)^r]^2 (r - 1)(1 - \Delta)^{r-2} - (1 - \Delta)^{r-1} 2[1 + (1 - \Delta)^r]r(1 - \Delta)^{r-1}}{[1 + (1 - \Delta)^r]^4} rD$$

$$\frac{\partial \varphi(\Delta)}{\partial \Delta} = \frac{[1 + (1 - \Delta)^r](1 - \Delta)^{r-2}}{[1 + (1 - \Delta)^r]^4} \{[1 + (1 - \Delta)^r](r - 1) - 2r(1 - \Delta)^r\} rD$$

$$\frac{\partial \varphi(\Delta)}{\partial \Delta} = \frac{[1 + (1 - \Delta)^r](1 - \Delta)^{r-2}}{[1 + (1 - \Delta)^r]^4} \{-(1 - r) - (1 + r)(1 - \Delta)^r\} rD < 0 \tag{A5}$$

This last inequality follows from the fact that $\Delta < 1$ and $r \in (0,1)$. This concludes the demonstration that $\underline{s}(\Delta)$ is a decreasing function of Δ.

Comparing the upper and lower bounds of the settlement range, it is clear that $\bar{s}(\Delta) > \underline{s}(\Delta)$ for $\Delta < 1$. Thus, the bargaining range is nonempty for all values of Δ. The Nash bargaining solution gives $s(\Delta) = (1-\theta)s(\Delta) + \theta\underline{s}(\Delta)$. Since both terms are decreasing functions of Δ, we know that $s(\Delta)$ is also decreasing in Δ. By taking a very short position, the plaintiff will be able to extract a settlement arbitrarily cost to D. As we saw above, in the limit as $\Delta \to -\infty$, $\pi(c_p^*, c_d^*) \to 1$ and $c_d^* \to 0$. Therefore, as $\Delta \to -\infty$, $\bar{s}(\Delta) \to D$ and $\underline{s}(\Delta) \to D$. ∎

Proof of Lemma 2. Taking the derivative of (11) with respect to $\hat{\pi}$ gives the slope:

$$\frac{\partial W^p(\hat{\pi}, \Delta)}{\partial \hat{\pi}} \equiv \left[\hat{\pi}D - c_p + (R - \hat{\pi}D - c_d)\Delta\right]f(\hat{\pi}) \tag{A6}$$

$$-[\hat{\pi}D + c_d + (R - \hat{\pi}D - c_d)\Delta]f(\hat{\pi}) + \int_{\hat{\pi}}^1 D(1-\Delta)f(\pi)d\pi$$

Canceling terms, this slope may be rewritten as

$$\frac{\partial W^p(\hat{\pi}, \Delta)}{\partial \hat{\pi}} \equiv -(c_p + c_d)f(\hat{\pi}) + (1-\Delta)D[1 - F(\hat{\pi})] \tag{A7}$$

Since $(\pi) > 0 \; \forall \pi \in [0,1]$, this slope is negative when $\hat{\pi} \to 1$. Therefore, the optimal $\hat{\pi} < 1$. Dividing by $1 - F(\hat{\pi})$, the slope is negative (positive) if and only if

$$\frac{(1-\Delta)D}{c_p + c_d} < (>) \frac{f(\hat{\pi})}{1 - F(\hat{\pi})}. \tag{A8}$$

The monotone hazard rate condition implies that the right-hand side strictly is increasing in $\hat{\pi} \in (0,1)$. It is equal to $f(0)$ when $\hat{\pi} = 0$ and approaches positive infinity as $\hat{\pi}$ approaches 1.

Define Δ_0 to be where $\frac{(1-\Delta_0)D}{c_p+c_d} = f(0)$. Suppose $\Delta \geq \Delta_0$. Using the monotone hazard rate condition, $\frac{(1-\Delta)D}{c_p+c_d} \leq \frac{(1-\Delta_0)D}{c_p+c_d} = f(0) < \frac{f(\hat{\pi})}{1-F(\hat{\pi})}$ for all $\hat{\pi} \in (0,1)$. This implies that $\frac{\partial W^p(\hat{\pi},\Delta)}{\partial \hat{\pi}} < 0$ for all $\hat{\pi} \in (0,1)$ and a corner solution is obtained at $\hat{\pi}(\Delta) = 0$.

Now suppose instead that $\Delta < \Delta_0$. In this case, $\frac{(1-\Delta)D}{c_p+c_d} > \frac{(1-\Delta_0)D}{c_p+c_d} = f(0)$. So $\frac{\partial W^p(\hat{\pi},\Delta)}{\partial \hat{\pi}} > 0$ when $\hat{\pi} = 0$ and an interior solution $\hat{\pi}(\Delta) \in (0,1)$ is obtained. Finally, we will show that $\hat{\pi}'(\Delta) < 0$ when an interior solution exists. Letting $\varphi(\hat{\pi}) \equiv \frac{f(\hat{\pi})}{1-F(\hat{\pi})}$ be the monotone likelihood ratio, we can write the first order condition as $\frac{(1-\Delta)D}{c_p+c_d} = \varphi(\hat{\pi})$. Totally differentiating, we have $\frac{-D}{c_p+c_d}(d\Delta) = \varphi'(\hat{\pi})(d\hat{\pi})$, and so the slope $\hat{\pi}'(\Delta) = \frac{d\hat{\pi}}{d\Delta} = \frac{-D}{(c_p+c_d)\varphi'(\hat{\pi})} < 0$ and we are done. ∎

Proof of Proposition 3. From Lemma 2, if $\Delta \geq> \Delta_0$ then $\hat{\pi}(\Delta) = 0$ and so $d\hat{\pi}(\Delta)/d\Delta = 0$. Therefore when $\Delta \geq> \Delta_0$ the ex ante payoff function (10) is constant in Δ. When $\Delta < \Delta_0$ then from Lemma 2 $\hat{\pi}(\Delta) \in (0,1)$ and $d\hat{\pi}(\Delta)/d\Delta < 0$. So, $\hat{\pi}(\Delta)$ is almost everywhere differentiable. Totally differentiating the plaintiff's ex ante payoff function (16) with respect to Δ gives:

$$\frac{dW^p(\hat{\pi}(\Delta), \Delta)}{d\Delta} = \left[-(c_p + c_d) f(\hat{\pi}(\Delta)) + D(1 - F(\hat{\pi}(\Delta))) \right] \frac{d\hat{\pi}(\Delta)}{d\Delta} \tag{A9}$$

We will now do a substitution for the case where $\Delta < \Delta_0$. Rewriting the first-order condition for the interior solution for $\hat{\pi}(\Delta)$ implied by (A7) as

$$-(c_p + c_d) f(\hat{\pi}(\Delta)) + D[1 - F(\hat{\pi}(\Delta))] = \Delta D[1 - F(\hat{\pi}(\Delta))] \tag{A10}$$

Substituting this into (A4), we have

$$\frac{dW^p(\hat{\pi}(\Delta), \Delta)}{d\Delta} = \Delta D[1 - F(\hat{\pi}(\Delta))] \frac{d\hat{\pi}(\Delta)}{d\Delta} \tag{A11}$$

When $\Delta < \Delta_0$ we have $\hat{\pi}(\Delta) \in (0,1)$, $1 - F(\hat{\pi}(\Delta)) > 0$, and $d\hat{\pi}(\Delta)/d\Delta < 0$. Therefore, the slope $dW^p(\cdot)/d\Delta$ has the same sign as $-\Delta$. When $\Delta < 0$ the plaintiff would want to raise Δ; when $\Delta > 0$ the plaintiff would want to lower it. If $\Delta_0 > 0$, then financial position $\Delta = 0$ is the unique optimum. If $\Delta_0 \leq 0$, financial position $\Delta = 0$ is weakly optimal as well (it is weak since all values $\Delta \geq \Delta_0$ yield $\hat{\pi}(\Delta) = \hat{\pi}(0) = 0$). ∎

Proof of Proposition 4. First, we show that there exists a unique fixed point $\Delta^* \in \Omega$ such that $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*)$. Lemma 2 implies that $\hat{\pi}(\Delta)$ exists, is continuous, and $\hat{\pi}'(\Delta) \leq 0$ for all $\Delta \in \Omega$. Since $\bar{\pi}\left(\frac{-c_p}{c_d}\right) = 0$, $\bar{\pi}\left(\frac{m(1)D - c_p}{m(1)D + c_d}\right) = 1$, and $\bar{\pi}'(\Delta) > 0$ from Lemma 3, there must be a fixed point $\Delta^* \in \Omega$ where $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*)$. Further, since $\hat{\pi}'(\Delta) \leq 0 < \bar{\pi}'(\Delta)$ for all $\Delta^* \in \Omega$, we have that if $\Delta < \Delta^*$ then $\hat{\pi}(\Delta) \geq \bar{\pi}(\Delta)$ and if $\Delta > \Delta^*$ then $\hat{\pi}(\Delta) < \bar{\pi}(\Delta)$.

Case 1: We consider two subcases. Suppose $\frac{-c_p}{c_d} \leq \Delta \leq \Delta^*$. We just showed that $\hat{\pi}(\Delta) \geq \bar{\pi}(\Delta)$. Suppose the plaintiff offers $\hat{\pi}(\Delta)D + c_d$ and the defendant accepts if and only if $\pi \geq \hat{\pi}(\Delta)$. Following the rejection of the offer, the plaintiff believes that $\pi < \hat{\pi}(\Delta)$. Given these updated beliefs, it is credible for the plaintiff to bring the defendant to trial following the rejection of the offer if:

$$m(\hat{\pi}(\Delta))D + c_d - \left(\frac{c_p + c_d}{1 - \Delta}\right) \geq 0 \tag{A12}$$

Recall that $\bar{\pi}(\Delta)$ is defined by $m(\bar{\pi}(\Delta))D + c_d - \left(\frac{c_p+c_d}{1-\Delta}\right) = 0$. Since $\hat{\pi}(\Delta) \geq \bar{\pi}(\Delta)$, we have that $m(\hat{\pi}(\Delta)) \geq m(\bar{\pi}(\Delta))$ and so the credibility constraint does not bind. Suppose $\Delta < \frac{-c_p}{c_d}$. The plaintiff has a credible threat to litigate even when he believes he is facing the very lowest defendant type with $\pi = 0$. So the credibility constraint is not binding and the plaintiff chooses settlement offer $\hat{s}(\Delta)$ with threshold $\hat{\pi}(\Delta)$.

Case 2: Suppose $\Delta \in \left(\Delta^*, \frac{m(1)D-c_p}{m(1)D+c_d}\right]$. We proved above that $\hat{\pi}(\Delta) < \bar{\pi}(\Delta)$ and so $m(\hat{\pi}(\Delta)) < m(\bar{\pi}(\Delta))$. We will now show that it is optimal for the plaintiff to offer $\bar{\pi}(\Delta)D + c_d$. To do this, we first prove the following claim.

> ***Claim 1.*** *Suppose* $\Delta \in \left(\Delta^*, \frac{m(1)D-c_p}{m(1)D+c_d}\right)$ *and the plaintiff offers* $\tilde{s} = \tilde{\pi}D + c_d$ *where* $\tilde{\pi} < \bar{\pi}(\Delta)$. *In equilibrium, the defendant types* $\pi < \bar{\pi}(\Delta)$ *reject the settlement offer and the plaintiff proceeds to trial with probability* $\sigma(\tilde{\pi}) = \frac{\tilde{\pi}D+c_d}{\bar{\pi}(\Delta)D+c_d}$.
>
> ***Proof of Claim 1.*** The proof follows the analysis in Nalebuff (1987) closely. Since $\Delta > \Delta^*$ (as we are in case 2), we have $\hat{\pi}(\Delta) < \bar{\pi}(\Delta)$ and so $m(\hat{\pi}(\Delta))D + c_d - \left(\frac{c_p+c_d}{1-\Delta}\right) < 0$. We cannot have a continuation equilibrium where the plaintiff always proceeds to trial following the rejection of $\tilde{s} = \tilde{\pi}D + c_d$. If that were true, then $m(\tilde{\pi})D + c_d - \left(\frac{c_p+c_d}{1-\Delta}\right) < 0$ and the plaintiff would drop the case, a contradiction. We cannot have a continuation equilibrium where the plaintiff always drops the case following rejection of the offer, $\tilde{s} = \tilde{\pi}D + c_d$. If that were true, then no defendant type would accept the offer. If all defendant types rejected, then since $\Delta < \frac{m(1)D-c_p}{m(1)D+c_d}$, we have $m(1)D + c_d - \left(\frac{c_p+c_d}{1-\Delta}\right) > 0$ and so the plaintiff would go to trial rather than drop the case (a contradiction). The equilibrium, therefore, will involve a mixed strategy. For the plaintiff to be indifferent between proceeding to trial and dropping the case after the rejection of settlement offer of $\tilde{\pi} < \bar{\pi}(\Delta)$, it must be that all defendants with types $\pi < \bar{\pi}(\Delta)$ reject the offer, so that, conditional on rejection, we have $m(\bar{\pi}(\Delta))D + c_d - \left(\frac{c_p+c_d}{1-\Delta}\right) = 0$. Let $\sigma(\tilde{\pi})$ be the probability that the plaintiff proceeds to trial upon rejection of $\tilde{\pi} < \bar{\pi}(\Delta)$. To make the defendant type $\bar{\pi}(\Delta)$ indifferent between accepting and rejecting the settlement offer $\tilde{\pi}D + c_d$ we need $\sigma(\tilde{\pi})(\bar{\pi}(\Delta)D + c_d) = \tilde{\pi}D + c_d$, from which we get $\sigma(\tilde{\pi}) = \frac{\tilde{\pi}D+c_d}{\bar{\pi}(\Delta)D+c_d}$. This concludes the proof of Claim 1. ∎

Coming back to the proof for case 2, now, we can show that the plaintiff's expected return is maximized by offering $\bar{\pi}(\Delta)D + c_d$. If the plaintiff chooses $\tilde{\pi} \leq \bar{\pi}(\Delta)$, the plaintiff's expected return can be written as:

$$\int_0^{\bar{\pi}(\Delta)} R\Delta f(\pi)d\pi + \int_{\bar{\pi}(\Delta)}^1 [\tilde{\pi}D + c_d + (R - \tilde{\pi}D - c_d)\Delta]f(\pi)d\pi - v_0(\Delta)\Delta \tag{A13}$$

The first term in this expression results from the plaintiff's indifference between going to trial and dropping the case following the rejection of the offer. Differentiating with respect to $\tilde{\pi}$, we get

$$D(1-\Delta)\left(1 - F\big(\bar{\pi}(\Delta)\big)\right) > 0 \tag{A14}$$

So the plaintiff would want to raise $\tilde{\pi}$ all the way up to $\bar{\pi}(\Delta)$. Now suppose instead that $\tilde{\pi} > \bar{\pi}(\Delta) > \hat{\pi}(\Delta)$. The plaintiff has a credible threat to litigate following the rejection of the settlement offer, and the plaintiff's payoff is $W^p(\tilde{\pi}, \Delta)$. Since $\tilde{\pi} > \hat{\pi}(\Delta)$, $W^p(\tilde{\pi}, \Delta)$ is decreasing in $\tilde{\pi}$. So the plaintiff would lower $\tilde{\pi}$ all the way down to $\bar{\pi}(\Delta)$.

Case 3: We now show that when $\Delta > \frac{m(1)D - c_p}{m(1)D + c_d}$ the plaintiff will never take the defendant to trial. Suppose that this was not true, and that the plaintiff offers $\tilde{\pi}D + c_d$ and takes the defendant to trial with probability $\tilde{\sigma}$ if the offer is rejected. In this case, the defendant would reject the offer if $\tilde{\pi}D + c_d > \tilde{\sigma}(\pi D + c_d)$. Rearranging terms, the defendant rejects the offer if $\pi \in \left[0, \frac{\tilde{\pi}D + c_d(1-\tilde{\sigma})}{\tilde{\sigma}D}\right)$. The expected value of π on this interval is certainly smaller than $m(1)$. Therefore, since $\Delta > \frac{m(1)D - c_p}{m(1)D + c_d}$, the plaintiff's threat to go to trial is never credible.

Therefore the plaintiff cannot succeed in extracting a settlement offer. ∎

Proof of Proposition 5. Taking the derivative of the plaintiff's ex ante payoff function with respect to Δ, we find that the slope is

$$\frac{dW_p(\pi^*(\Delta), \Delta)}{d\Delta} = \left[-(c_p + c_d)f(\pi^*(\Delta)) + D(1 - F(\pi^*(\Delta)))\right]\frac{d\pi^*(\Delta)}{d\Delta} \tag{A15}$$

Notice the similarity between the expression in brackets and the slope of the interim payoff function in the text. The only difference is that in the interim payoff function, the financial position Δ has a direct impact on the slope while here it does not.

Case 1: $0 < \Delta^*$. This proof mirrors the proof of Proposition 3. Since $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*) > 0$, we have that $0 < \Delta^* < \Delta_0$. By Proposition 4 the plaintiff would choose threshold $\pi^*(\Delta) = \hat{\pi}(\Delta)$ for all $\Delta < \Delta^*$ and by Lemma 2 $\hat{\pi}(\Delta) \in (0,1)$ and $\frac{d\hat{\pi}(\Delta)}{d\Delta} < 0$. For $\Delta < \Delta^* < \Delta_0$ the threshold $\hat{\pi}(\Delta)$ satisfies

$$-(c_p + c_d)f(\hat{\pi}(\Delta)) + (1-\Delta)D[1 - F(\hat{\pi}(\Delta))] = 0 \tag{A16}$$

which implies

$$-(c_p + c_d)f(\hat{\pi}(\Delta)) + D[1 - F(\hat{\pi}(\Delta))] = \Delta D[1 - F(\hat{\pi}(\Delta))] \tag{A17}$$

Substituting above, we see that $\frac{dW_p(\cdot)}{d\Delta}$ has the same sign as $\Delta \frac{d\hat{\pi}(\Delta)}{d\Delta}$ which has the same sign as $-\Delta$. When $\Delta < 0$ then the plaintiff is better off raising Δ and when $\Delta > 0$ the plaintiff is better off lowering it. So the best Δ for the plaintiff is $\Delta = 0$.

Case 2: $\Delta^* = -\frac{c_p}{c_d} < 0$. Since $\bar{\pi}\left(-\frac{c_p}{c_d}\right) = 0$, we have a corner solution with $\hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*) = 0$. Since $\frac{d\hat{\pi}(\Delta)}{d\Delta} \leq 0$ we must have $\hat{\pi}(\Delta) = 0$ for all $\Delta > \Delta^*$ so $\hat{\pi}(0) = 0$. In other words, if the plaintiff could commit to a strategy, they would make an offer that all defendant types accept and then take anyone who rejects to trial. This is not credible when $\Delta = 0$, since $\bar{\pi}(0) > 0$, but it is credible when $\Delta = \Delta^*$, since by proposition 4 the plaintiff will choose $\pi^*(\Delta^*) = 0$. The plaintiff is weakly worse off choosing $\Delta < \Delta^*$, since $\pi^*(\Delta) = \hat{\pi}(\Delta) \geq 0$ in this range. The plaintiff is strictly worse off with $\Delta \in \left(\Delta^*, \frac{m(1)D - c_p}{m(1)D + c_d}\right)$ since $\pi^*(\Delta) = \bar{\pi}(\Delta) > 0$ in this range. Since $\frac{d\bar{\pi}(\Delta)}{d\Delta} > 0$ for all $\Delta \in \left(\Delta^*, \frac{m(1)D - c_p}{m(1)D + c_d}\right)$, we know that the plaintiff's payoff is falling as Δ rises. Therefore $\Delta = \Delta^*$ maximizes the plaintiff's expected ex ante payoff.

Case 3: $\Delta^* \in \left(-\frac{c_p}{c_d}, 0\right)$. Note that $\pi^*(\Delta^*) = \hat{\pi}(\Delta^*) = \bar{\pi}(\Delta^*) > 0$. Since $\hat{\pi}(\Delta^*) > 0$, we have that $\frac{d\hat{\pi}(\Delta^*)}{d\Delta} < 0$ and so $\hat{\pi}(\Delta^*) > \hat{\pi}(0)$. If the plaintiff chooses $\Delta < \Delta^*$, then by Proposition 4 and since $\frac{d\hat{\pi}(\Delta^*)}{d\Delta} < 0$ we have $\pi^*(\Delta) = \hat{\pi}(\Delta) > \pi^*(\Delta^*)$. If the plaintiff chooses $\Delta > \Delta^*$ then since $\frac{d\bar{\pi}(\Delta)}{d\Delta} > 0$ we have $\pi^*(\Delta) = \bar{\pi}(\Delta) > \pi^*(\Delta^*)$. By choosing $\Delta = \Delta^*$, the plaintiff gets the outcome closer to $\hat{\pi}(0)$. ∎

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